THE HOPE REPORTS

VOL. IV

1900—1903

EDITED BY

EDWARD B. POULTON, M.A., D.Sc.

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PRINTED FOR PRIVATE CIRCULATION

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1903

THE MAKERS OF THE HOPE DEPARTMENT
OXFORD UNIVERSITY MUSEUM

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PREFACE

The fourth volume of Hope Reports contains a large number of papers published in the period 1900–1903. The Annual Reports of the Hope Professor, published in the University Gazette, indicate that the study of African species and of African bionomics is pursued with especial energy in the Department, and by those who are in continual correspondence with it, especially Mr. Guy A. K. Marshall. It so happened that several memoirs on these subjects were published in the year 1902, and as they were sufficient to make up a volume by themselves, No. III of the Hope Reports, dealing with African natural history, was issued early in 1903. Hence the years 1900–1903 have furnished material for two volumes of these Reports.

Papers 2 to 12 deal with insect bionomics and other questions relating to evolution and natural selection in this group of animals. The first paper, on 'Mimicry and Natural Selection,' is a reprint of the English address to the International Zoological Congress at Berlin on Aug. 15, 1901. Mr. N. Annandale's work (3) upon the material collected in the Malay Peninsula was largely carried on in the Hope Department. Mr. Shelford's important memoir (4) on Bornean mimicry was written in Sarawak, but nearly all the specimens were sent to the Hope Department for study and identification, and many additions to

the paper were thus brought about. Furthermore, by the generosity of the author, the great majority of the specimens, in fact all except the unique ones, have been presented to the Department, so that the monograph does actually treat of Oxford material, and the subject itself can be better studied in Oxford than in any other place outside the Indo-Malayan Sub-Region. The sixth paper, a criticism of the hypothesis of 'Conscious Protective Resemblance,' is in part by Mr. Guy A. K. Marshall, in part by the Hope Professor. Dr. F. A. Dixey contributes an interesting account (7 and 8) of Lepidoptera from the White Nile, kindly presented to the Department by Mr. W. L. S. Loat, together with further notes on seasonal dimorphism in butterflies. Mr. Guy Marshall's demonstration, by breeding, of the wet and dry phases of *Precis actia* is described in (10). The specimens themselves, which have historic value and interest, have been generously presented to the University. The first investigation into insect bionomics undertaken in the Department forms the subject of the tenth memoir. The publication was delayed many years because the notes and drawings were mislaid in 1894 during the alterations. Two other short papers on insect bionomics (5 and 9) are also by the Hope Professor, together with a brief sketch (12) of the influence of Darwin upon Entomology.

Papers 13 to 20 inclusive deal with systematic and faunistic questions. A valuable account (13 and 14) of the Oxford types belonging to the Hemipterous families *Pentatomidae* and *Coreidae* is given by Mr. W. L. Distant. Interesting new spiders presented by Mr. Shelford and Mr. Marshall are described (15) by the Rev. O. Pickard-Cambridge. Papers 16 to 19 inclusive treat of the collection of Balearic insects made in 1900 by the Hope

Professor, Mr. Oldfield Thomas, and Mr. R. I. Pocock; the *Hymenoptera Aculeata* and the *Hemiptera-Heteroptera* by Mr. Edward Saunders, the *Diptera* by Col. J. W. Yerbury, and an Introduction by the Professor. Mr. S. A. Neave describes (20) a new species of *Lycaenid* kindly presented by Mr. C. A. Wiggins.

The series of papers concludes with the Report (21) of the Professor for the year 1902.

EDWARD B. POULTON.

HOPE DEPARTMENT OF ZOOLOGY,
UNIVERSITY MUSEUM, OXFORD,
November 9, 1903.

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Mimicry and Natural Selection.

BY

E. B. Poulton,

HOPE PROFESSOR OF ZOOLOGY, OXFORD.

(SONDERABDRUCK AUS DEN VERHANDLUNGEN DES V. INTERNATIONALEN ZOOLOGEN-CONGRESSES ZU BERLIN, 1901.)

VERLAG VON GUSTAV FISCHER IN JENA.

1902.

Mimicry and Natural Selection.

By **E. B. Poulton** (Oxford).

I feel it to be a great honour and pleasure to be called on to deliver the address on behalf of the English-speaking nations at the fifth International Zoological Congress at Berlin. At the same time I am sensible of the great difficulty of the task, the attempt to say anything adequate on so wide a subject in the narrow compass of five and forty minutes.

In attempting to arrive at a decision upon the origin and cause of mimetic resemblance we have no direct evidence to assist us. We are driven to base our opinion upon the same ground as that upon which the belief in the theory of gravitation is founded. This theory finds acceptance, not because of direct evidence in its favour, but because the facts of the cosmos, so far as we know them, are consistent with the theory and none of them inconsistent with it.

It is necessary therefore first to give a brief account of the theories which have been advanced to account for the origin of Mimicry, secondly to enquire how far each one of them is consistent with the main facts of Mimicry. 1) The theory of Natural Selection as an explanation, assumes that these resemblances have been produced because they are and have been useful in the struggle for existence. There has been according to this interpretation a greater average survival in successive generations of the forms in which these useful likenesses were more strongly developed as compared with those in which they were less strongly developed, and thus in process of time a very high degree of resemblance has been attained. 2) The theory of External Causes assumes that mimicry has been produced by the direct action upon the organism of some one or more of the various influences which exist in the locality, such as food, moisture, dryness, heat, cold &c. 3) The theory of Internal Causes assumes that mimetic resemblances are due to the independent arrival of different species at the same evolutionary stage, as regards the characters in which such resemblances are manifest. 4) The theory of Sexual Selection has occasionally been invoked to account for mimicry, the assumption being that the selection of mates has been influenced by the colours and patterns of other species living in the same country.

The last mentioned theory is believed to account for mimicry by comparatively few naturalists, although it was deemed to be worthy of consideration by Charles Darwin and Fritz Müller[1]).

1) See a letter from Charles Darwin describing Fritz Müller's thoughts on this subject. „Charles Darwin and the Theory of Natural Selection." Poulton, London 1896, p. 202.

The theory of External Causes is probably more commonly received as an explanation than any of the others except Natural Selection itself.

I now propose to bring before you several illustrations, setting forth the main aspects of mimetic resemblance, and to inquire how far each of them is consistent with these four theories. All the coloured illustrations were made by Mr. Sanger-Shepherd who took photographs of the actual specimens in the Hope Department of the Oxford University Museum and prepared from the negatives the three-colour films which are superposed in the slides. Hence the exact patterns of the insects are faithfully represented by physico-chemical means.

The too-exclusive study of mimicry in Lepidoptera alone is probably responsible for a common belief in the theory of External Causes. Thus when we contemplate a group of many species of Heliconine, Ithomiine, Danaine, Erycinid, and Pierine butterflies from British Guiana and Surinam, and find that all tend to develope dark hind wings, it is plausible to suggest as an interpretation that we are witnessing the common effect of local influences. But this and every other explanation, except natural selection, leave as a mere coincidence the fact that the first-named three groups contribute the vast majority of the species, and undoubtedly provide the models for the others. Under Natural Selection the interpretation is easy; the groups in question are specially defended by unpalatable qualities and it is to their advantage to warn their enemies by a common advertisement. The Erycinid and Pierine species may also be unpalatable and fall into the same Müllerian (Synaposematic)[1]) combination, or they may be edible and gain advantage by living on the reputation of the three nauseous Nymphalid sub-families (Batesian mimicry or Pseudaposematic resemblances). Taking all available facts into consideration the former is the more probable view. Not in Guiana alone, but whereever we may travel in tropical America groups of species of these three Nymphalid sub-families tend to resemble each other and to act as models for butterflies of other families and sub-families. In Venezuela, for example, they are amber-coloured black-barred insects as in Guiana but without the tendency towards preponderant black in the hind-wings; in South Eastern Brazil they all possess an especially light stripe, frequently bright yellow, along the hind-wings, and a light spot, frequently white, at the apex of the fore-wings; at Ega, on the upper Amazon, they all gain a rich chestnut brown ground colour; still further west, the brown ground colour is much less dark than at Ega, and of a very characteristic shade. Why should these three sub-families be so conspicuously subject to the common influence of

1) Proceedings Entom. Soc. London, 1897, p. XXIX.

locality, why should they more than all other Rhopalocera arrive independently at the same evolutionary stage as regards visible characters, why should sexual selection operate so exclusively upon them in the direction of producing a common likeness? None of these questions can be answered. The facts remain mere coincidences under all theories except Natural Selection. In other words Natural Selection is the only satisfactory interpretation.

Mimicry among Rhopalocera is much less common as we pass into northern regions, but there is one excellent example in temperate North America which serves to shew how superficial an interpretation is that offered by the theory of External Causes and how completely it breaks down when examined with a little care. With comparatively few exceptions the insect fauna of the Nearctic Region is that of the great northern circumpolar land-belt. These exceptions are intruders from the tropical South, and among them is the large Danaine butterfly Anosia plexippus which now ranges over the United States and a large part of Canada. In tropical America closely similar representative species, sub-species or forms still persist. This abundant Danaine butterfly affords the model which is closely resembled by an indigenous Nymphaline butterfly which we should place in the genus Limenitis, although some American naturalists prefer to put the Nearctic species in a separate genus, Basilarchia. There are also other mimics among the species of the North American Limenitis (Basilarchia), but two of them are non-mimetic and enable us to reconstruct the appearance of their close ally before the intrusion of the great Danaine model. In the New World the genus Limenitis is confined to the Nearctic Region with the exception of a single species, a form of the mimetic L. astyanax (Fabr.), which just enters the borders of Mexico. If butterfly colours and patterns are the expression of the direct influences of the environment, then it is clear that the indigenous non-mimetic species of Limenitis (Basilarchia) are an expression of Nearctic conditions, and according to the theory of External Causes, the invader from the South should have come to resemble them instead of drawing an ancient Nearctic species far away from the ancestral colours and patterns into a close superficial likeness to itself. The fact that certain species of a single genus should thus be entirely mimetic while others are entirely non-mimetic and preserve the ancestral appearance, has been sometimes urged, for example by late Professor J. O. Westwood, against the interpretation afforded by the theory of Natural Selection. It is a real difficulty to the theories of external and internal causes; for, as regards the first, we should expect the closely related species of a genus to react similarly to the local conditions rather than that certain of them should react quite differently from the others but quite similarly to the species of distantly related sub-families; and, as

regards the second, we should expect such species to reach nearly the same evolutionary stage together, rather than that some should reach one stage and others another entirely different one, but the same as that reached by certain species of remote affinity. With Natural Selection for our explanation such differences are at once intelligible. The variation which formed the foundation for selection to build upon may well have been present in certain species of a genus but not in others; or slight differences in life-history or the methods of adaptation, or the attacks of enemies may have rendered mimicry advantageous for this species but not for that.

When we pass from mimicry among butterflies to mimicry between butterflies and moths the difficulties encountered by all theories except Natural Selection become greater because of the wider structural difference between model and mimic. To take an example, certain species of day-flying Chalcosid moths of Borneo mimic Danaine butterflies while others mimic Pierinae. Why should part of the Heteroceran group be acted on by external conditions to as to cause a superficial resemblance to Danainae the others so as to cause a resemblance to Pierinae? Why out of the same closely related set of species should some reach the evolutional stage of Danainae, the others of Pierinae? Why should the models happen to differ from butterflies in general in their slow flight and conspicuous appearance, in the similarity of the patterns on the under side of the wings to those on the upper side, in the fact that they are distasteful to the generality of insect-eating animals? Why should the mimics happen to belong to a day-flying group although moths are as a rule nocturnal? All these questions receive an obvious answer when the theory of Natural Selection is adopted as the explanation of mimicry: they cannot be answered by any other existing theory. Under any other theory the facts are gratuitous, devoid of meaning.

When the model belongs to one insect order and the mimic to another, difficulties of interpretation, except on the theory of Natural Selection, become even greater. Why should the models in the vast majority of cases happen to belong to the Hymenoptera and to possess stings or other special modes of defence? Why under the totally different conditions of Borneo and South Africa should a local Xylocopid bee be mimiced by a local Asilid fly (Hyperechia)? Many moths come to resemble transparent-winged Hymenoptera by the actual loss of scales which were present on their wings when they emerged from the pupa. Is anyone bold enough to maintain that a resemblance thus caused is due to External or Internal Causes or to Sexual Selection?

The assumption that local influences act uniformly on different species is by no means justified except in the case of species with similar habits and life-histories: Mr. Guy A. K. Marshall has sent me a wonderful group of reddish brown or ochreous insects with the

posterior part of the visible dorsal surface black. It contains many species of the Lycid models, and also Coleoptera belonging to the Telephoridae, Melyridae, Phytophaga, Cantharidae, and Longicorns, several species of aculeate Hymenoptera, a few Hemipterous insects, two species of Lepidoptera Heterocera and one of Diptera. We have here all kinds of habits and all kinds of life-histories, larvae living in the open, larvae burrowing in plant-stems, carnivorous larvae, leaf-eating larvae, larvae with special food stored in cells. It is simply childish to appeal vaguely to the direct action of like forces as the explanation of the remarkable likeness which runs through the group: for the environing forces are not like but extremely unlike, because of the very diverse conditions under which various members of the group live and grow.

All the butterfly sub-families which furnish the chief models for Mimicry are remarkable for a uniformity of colour and pattern among groups of species in each of the countries they inhabit. These sub-families are the Danainae found all over the tropics, and the allied Ithomiinae (Neotropinae) of tropical America, the Acraeinae almost confined to Africa and tropical America, and the allied Heliconinae practically restricted to the latter. A very strong family likeness runs through long series of species, as anyone may see by a glance at the successive drawers of a collection of African Acraeinae or Oriental Euploeina and comparing them with an equal number of species in any sub-family which does not provide models for Mimicry. Compare for instance our European Vanessidae with sets of local species of any of the four above-named sub-families. The species of Vanessa do indeed possess homologous markings[1]) and many of the gaps between them can be filled up, but we have to hunt the world in order to do it, and even then we only obtain a partial continuity between extreme differences, whereas in the specially protected sub-families there is not only continuity but uniformity in large groups of species. Mr. A. G. Mayer[2]) has found that among 450 species of Neotropical Ithomiinae and Heliconinae there are only 15 shades of colour, whereas among 200 species of Neotropical Papilioninae there are 36 shades. And this is not by any means due to the scarcity of variation in the former; for individual differences in each locality, aud geographical differences, as we pass from one district to another, are very prevalent. Combined with the uniformity within these sub-families is a marked tendency to resemble other protected sub-families within the same region, a tendency which is so pronounced in the case of the Ithomiinae and Heliconinae that they were long regarded as a single group although

1) See F. A. Dixey in Trans. Entom. Soc. London, 1890, p. 89.
2) Bulletin of the Mus. of Comp. Zool. at Harvard Coll., Feb. 1897, p. 169.

the structural differences between them, as larva, pupa and imago, are strongly marked and indicate that the first sub-family belongs to one side of the great Nymphalid family and the second to the opposite side. This remarkable uniformity in the species of certain butterfly sub-families was first explained by Professor Meldola[1]) on the lines suggested by Dr. Fritz Müller[2]) in 1879, viz. as an adaptation in order to reduce the amount of life sacrificed during the period when young and inexperienced insect-enemies are learning to distinguish between palatable and unpalatable (and perhaps unwholesome) food. If two species living intermingled and equally numerous are superficially exactly alike, and both nauseous, each will lose only half the number of individuals which would have been required in order to educate their enemies if they had been dissimilar. The sacrifice of life is also reduced by the strong general resemblance running through the species of each specially protected sub-family in one country. Such resemblance is by no means confined to the Rhopalocera or the Lepidoptera. It is found abundantly in all specially defended insect orders, principally the Hymenoptera. If we look at the Australian Aculeata we notice a large group of species in which the orange ground colour is deeper and browner than in banded Aculeata generally, while the black zones are broader and fewer, being in fact usually reduced to two, one crossing the thorax, another the abdomen. This very characteristic appearance is to be found in Abispa, Eumenes, Alastor, Odynerus, Bembex and probably many other genera: it also occurs in mimetic Diptera (Asilidae) and Longicorn Coleoptera. Here is a broad fact which receives an intelligible explanation by Natural Selection but by no other theory which has been suggested. We can well understand on the theory of Natural Selection why the members of specially defended groups should be far more alike than those of others, why they should resemble members of other such groups in the same region, why they should have conspicuous patterns and contrasted colours which in Lepidoptera tend to be the same upon the under as on the upper side of the wings, why their flight should be slow and flaunting, why they should be remarkably tenacious of life. Here are a number of important characters associated together and true of all such groups wherever they may occur in any part of the world. One theory alone explains all the numerous observations which are here condensed into a brief statement. It is by no means an assumption to maintain that the groups in question are specially defended. This is admitted to be the case with the Hymenoptera and there is now a very large mass of experimental evidence in the Lepidoptera[3]).

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1) Ann. and Mag. Nat. Hist., Dec. 1882, p. 417.

2) Kosmos, May 1879, p. 100; also Kosmos, V, 1881.

3) See especially Frank Finn in Journ. Asiat. Soc. Bengal LXIV, pt. II, 1895, p. 344; LXV, pt. II, 1896, p. 42; LXVI, pt. II, 1897, p. 528; LXVII. pt. II, 1897, p. 614.

Another admitted fact of wide application is the tendency of mimetic resemblance to appear in the female rather than the male. Thus female butterflies of many species are associated with non-mimetic males while the converse relationship is almost unknown. The non-mimetic male in the species referred to maintains the ancestral appearance which has been lost in the female, although distinct traces of it can nearly always be recovered by the careful study of individual variation, and comparison with allied species. This is a remarkable reversal of the ordinary rule that when male and female differ the latter is the more ancestral. This striking exception is quite unintelligible except under the theory of Natural Selection which offers the convincing explanation, long ago suggested by Alfred Russel Wallace, that the slower flight of the heavier females and their exposure to attack during oviposition render it especially advantageous for them to resemble conspicuous distasteful species in the same locality[1]).

Another aspect of Mimicry affords, in my opinion, perhaps the most powerful argument of all in favour of an interpretation based on the theory of Natural Selection. If these resemblances are attained by selection because they are advantageous in the struggle for life we should expect to find that they are produced in a great variety of ways; for one species would reach the beneficial end by one path pointed out to it by the structure it possessed at the beginning and by the trend of its variation, while another species with a very different initial structure would reach the same end by a widely different path. Thus many Diptera, for example species of Ceria, gain a superficial resemblance to wasps by a narrowing in the anterior abdominal region which suggests the characteristic peduncle of a Hymenopterous insect. On the other hand Longicorn beetles of the genus Oberea gain the same effect by a patch of white which obliterates the anterior abdominal region with the exception of a small linear remnant representing the peduncle. In brilliant illumination the white is not seen as part of the insect. The resemblance of the Locustid Myrmecophana fallax to an ant is produced in the same manner. The Homopterous family Membracidae are characterized by an enormous growth of the dorsal region of the pro-thorax which spreads backwards and in many species covers the insect like a shield. In the American species which mimic ants this shield, and not the insect beneath it, becomes ant-like. Some of the larval Membracidae are laterally compressed, becoming in the dorsal region as thin as a leaf, and the body is green like a leaf, while the head and legs are brown. The whole appearance is singularly like that of the tropical American ant Oecodoma cephalotes carrying its leaf vertically in its mandibles and thrown over its back so that the

1) Trans. Linn. Soc. Lond., Vol. XXV, 1866, p. 22.

brown head, legs, and part of the body are seen beneath the green burden [1]). It is manifestly absurd to attempt to account for this series of mimetic resemblances by an appeal to the operation of External or Internal Causes or of Sexual Selection. There remains Natural Selection which at once offers a convincing interpretation. Ants and wasps are known to be aggressive dominant insects avoided by the majority of insect-eating animals, although certain species are adapted to feed almost exclusively upon them. It is in every way probable that a superficial resemblance to ants and wasps would be beneficial in the struggle for existence. There is indeed some experimental evidence to prove that real advantage is conferred [2]). We find that species of many groups mimic ants and wasps in a variety of entirely different ways. The results are exactly what might there been predicted to occur if Natural Selection be the efficient cause of mimetic resemblance.

The attempt has been made, in recent years, to cut away the foundation of an interpretation based on the theory of Natural Selection, by calling in question the conclusion that butterflies are, as a matter of fact, attacked by insect-eating animals such as birds. I have recently collected together a great mass evidence bearing on this point, most of it obtained in Mashonaland, South Africa, by the admirable naturalist Mr. Guy A. K. Marshall. This material conclusively proves that the wings of fresh unworn specimens of butterflies are constantly notched as if by the attacks of birds and lizards, and that in a considerable proportion of the examples the notches on opposite sides fit together, proving that the insect was seized when its wings were in contact. The attacks are most frequently directed to the posterior angle of the hind wing, less frequently to the tip of the fore wing, still less frequently to the intermediate borders and angles. The points of attack are those where special marks and structures, probably having a directive function, are frequently developed. Thus the tip of the fore wing is frequently rendered specially conspicuous and the posterior angle of the hind wing is continually produced into so-called „tails“ (Papilio, Charaxes etc.) which in the Lycaenidae are often antenna-like and associated with eye-spots, suggesting the appearance of a head, a resemblance further intensified by movements of the hind wings during the resting position which cause the apparent antennae to pass and repass each other. Such structures and marks are constantly injured or entirely bitten away in fresh specimens. Direct observation of actual attack by birds and lizards has also

1) See description and figure of a specimen found by Mr. W. L. Sclater in British Guiana. Poulton, in Proc. Zool. Soc., 1891, p. 462.

2) Poulton, „Colours of Animals“, London 1890, p. 247: Lloyd Morgan „Animal Behaviour“, London 1900, p. 164, 165.

been made by Mr. Marshall and others[1]), so that it may be safely assumed that the doubts thrown upon the reality of the struggle for life in butterflies have their origin in the want of observation specially directed to this end. The majority of naturalist-travellers are chiefly concerned with collecting and it is not surprising that many of them have not seen what they never looked for.

If time had permitted many other aspects of mimetic resemblance might have been dwelt upon, and it would have been found, as it has been found with those which I have had the honour to bring to your notice, that all are readily explicable by the theory of Natural Selection whereas they remain mere coincidences under any other alternative theory as yet suggested[2]).

1) Two members of the V. International Congress who were present at my lecture informed me afterwards that they had witnessed such attacks. Professor E. Pénard of Geneva saw a bird, probably a sparrow, persistently pursue and at the third attempt capture a white butterfly (probably a species of Pieris). The incident happened in the early summer of 1900, in a Park near Geneva. Mr. F. Muir of Ipswich, England, expressed surprise that any such doubts should have been raised. He had frequently observed such attacks at Delagoa Bay and other places on the East coast of Africa and had seen birds waiting in trees or bushes and darting out at butterflies as they approached.

2) Further evidence is discussed in the writer's paper in the Journ. Linn. Soc. Zoology, Vol. XXVI, p. 558.

[*From the* PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON, December 4, 1900.]

Observations on the Habits and Natural Surroundings of Insects made during the "Skeat Expedition" to the Malay Peninsula, 1899-1900. By NELSON ANNANDALE, B.A.[1]

CONTENTS.

I. INTRODUCTION.

The observations which form the subject of this paper were made in the months of April to September, 1899, while I was a member of Mr. W. W. Skeat's expedition to the Siamese Malay States. I take this opportunity of expressing my thanks to the University of Cambridge for permitting me to join that expedition as a

[1] Communicated by Prof. E. B. POULTON, F.R.S., F.Z.S.

volunteer, and also of saying how much I am indebted to Professor Poulton, F.R.S., of Oxford, and to Dr. David Sharp, F.R.S., of Cambridge, who have aided me in ways too numerous for specification. I also must thank Mr. Malcolm Burr, F.Z.S., F.E.S., for identifying many of the Orthoptera mentioned. The immaturity of many of my specimens has made it impossible to place them more definitely than by saying that they belong to such and such a family; in at least one instance even this has been impossible. In the few cases in which species are new to science I have not ventured to name them, as that is more properly the task of the specialist who describes them from a systematic or anatomical point of view. The immense importance of climatic and other physical conditions of life in the consideration of an animal's habits has induced me to preface my observations with a short general account of the country through which we passed, especially as little is known of the geography of lower Siam. I found a knowledge not only of the native names of animals but even of the native stories in connection with them to be of such value in my work, both as a collector and as an observer, that I have treated the etymology and what may be called the mythology of the subject at greater length than is perhaps usual in a zoological paper.

The climate of lower Siam is extremely damp, and is not divided into regular seasons in most districts, though more rain is liable to fall during the winter (November, December, and January) months than at any other time of the year. The most northerly State that we visited, except for a hurried trip to the Tale Noi (Little Lake) in Ligor, was Patalung, which abuts on the Tale Sap or Great Lake of Singora. In Patalung the rainfall is very small in March and April, but the jungle is never parched by drought. The interior of the eastern States is mountainous, and is buried in deep jungle, which is only broken, along the banks of the numerous rivers, by villages; clearings for hill rice, bananas, and maize; and by lawns, which are cropped smooth by half-tamed or feral buffaloes. The soil on the sea-coast is sandy, and in some places produces only a scanty vegetation. Between the mountains and the sea there is a great plain, dotted with isolated hills, mostly of limestone, some of which reach a considerable height, and some of which are riddled with caves. The mountain-region is the dampest of the three, being subject to violent thunderstorms, which are very local and lose much of their violence before they reach the coast. In nearly all regions rain falls almost daily for the greater part of the year.

A very large proportion of my observations were made at Aring, in the hill-country of Kelantan, the most southerly of the States which I visited. Aring is a village in the midst of exceedingly dense jungle, which commences close to the houses. The specimens which we obtained there were comparatively few in number, but very many of the species were peculiar in one way or another. Biserat in Jalor, the only other place where we stayed for more than a few days at a time, is in the plains, at the base of some hills

of no great height about 25 miles from the coast; it is the Siamese headquarters of the State. At Biserat we obtained a very large number of specimens, including probably more individuals and species than did the rest of our land collections; but very few of the species were highly specialized. Every sort of environment is to be found near a place like Biserat: swamp, lawn, orchard, open wood, cave, river, and even jungle on the hills, but not jungle of the densest. The animals in such a locality have no need to adapt themselves to any very limited environment, they can choose what environment they will. In the deep jungle, on the other hand, though few animals of any sort are seen on the ground, the fiercest struggle for existence rages among the upper foliage and also in the rotten wood underfoot—though there the termites, as a rule, far outstrip all competitors; while, even in the clearings, the space and the food-supply is so limited that every animal must make the best use of its natural advantages or else disappear. Though the clearings are of recent formation, due to man, who has become no longer a savage, yet the struggle which goes on in them seems already to have led in many cases to extreme modifications in habit and structure. We can only suppose that this struggle commenced long ago in places such as sand-spits running out into the rivers, where vegetation was necessarily scanty, owing to poverty of soil or constant change of conditions.

II. Flower-like Mantidæ.

Hymenopus bicornis (pupa).

Colour.—Head: very pale grey, almost white. Eyes of same shade, but with a slightly darker longitudinal stripe running down the centre of each. Leaf-like process between the eyes white, with median vein of pale green. Antennæ black.

Thorax: prothorax pale pink, with a tendency towards mauve; shading off posteriorly to white, and finally bounded by a bold transverse bar of deep sage-green. The posterior region of the thorax, which was usually concealed by the upturned abdomen, was pearl-white, as were also the rudimentary wings.

Abdomen: ventral surface pale pink. Dorsal surface pale pink, with 5 longitudinal dotted stripes of deep yellow-brown. Near the junction with the thorax were several irregular transverse bars of the same colour, but slightly darker. At the extreme tip of the abdomen, surrounding the anus, was a very conspicuous dark patch, almost black.

Limbs: 1st pair pale translucent pink. 2nd and 3rd pairs pink of a deeper shade, with a more marked tendency towards mauve. The distal joints were horn-coloured and almost transparent. At the inner edge of the broad petal-like expansions on the femur of the 2nd and 3rd pairs, more conspicuous on the 3rd than on the 2nd, was a slightly livid, bruise-like mark, such as one sees on flowers that have been battered by tropical rain.

The whole surface of the trunk and that of the flattened

expansions of the femur of the posterior limbs had that semi-opalescent, semi-crystalline appearance that is caused in flower-petals by a purely structural arrangement of liquid globules or of empty cells. On the grasping-limbs and on the extremities of the other pairs the absence of this peculiar sheen was compensated for by the translucency of the integument and the tissues—a translucency more proper to Cœlenterates than to an air-breathing insect. The petals of *Melastoma polyanthum*, the flower with which the Mantis was found associated, are of mauve-pink on the upper surface, slightly darker in tone than that of the limbs of the insect. Their lower surface, and consequently the visible surface of the older flower-buds, is considerably darker than the upper, more like that of the Mantis's abdomen. The leaves are of the same shade of green as the bar across its thorax. The flower was in bloom in

Fig. 1.

Pupa of *Hymenopus bicornis* on inflorescence of *Melastoma polyanthum*. (Photographed from life.)

The Mantis is seated in an upright position, with the abdomen flexed backwards. The photograph represents it as it is seen on a level with the eye, and shows the horn-like eyes of the insect (at the apex of figure), the V-shaped bar on the thorax, the predatory limbs folded in front of the body, the petal-like expansions of the femora of the 2nd and 3rd pairs of legs arranged on the flowers, and the ventral surface and dark tip of the abdomen. The tarsus of the left leg of the 3rd pair is seen stretching out from beneath the expansion of the femur to a seed-vessel of the plant.

Patalung at the end of March, and not yet completely passed at Aring in the middle of September; but possibly the flowering-season does not exactly coincide in the two districts. I know of no other flower at all like it in the jungle of lower Siam. A rarer species of the same genus, very similar in general appearance, is found in the clearings.

Habits and Attitude.—The only specimen which I obtained was caught about midday on August 17th in a buffalo-lawn near Kampong Aring, a village in the Ulu Lebeh district of Kelantan—that is to say, almost at the centre of the broad part of the Malay Peninsula. I was attracted to a bush of the "Straits Rhododendron" (*Melastoma polyanthum*) by a curious movement among the flowers of a large inflorescence at the height of about five feet above the ground. On a cursory examination I could only see that one of the flowers—so it appeared—was swaying slowly from side to side; and it was not for several seconds that I realized that the moving

Fig. 2.

Pupa of *Hymenopus bicornis* on inflorescence of *Melastoma polyanthum*. (Photographed from life.)

The same specimen as in figure 1, viewed from above, showing the dotted lines on the dorsal surface of the abdomen and the bruise-like markings on the expansions of the femora of the 3rd pair of legs. The head and fore limbs are slightly out of focus, and part of the bar on the thorax appears behind them. This photograph shows the difference in shape between the expansions on the legs of the Mantis and the petals of the flower.

[5]

flower was not a flower at all, but a Mantis. Even then it betrayed itself by turning round and staring me in the face in the manner characteristic of the Mantidæ. When I held the branch on which the insect had established itself in my hand, I could not tell exactly where animal tissue commenced and where flower ended, so perfectly was the one assimilated to the other, not only in colour but in surface texture, and perhaps even to some degree in structure. The Mantis had ensconced itself in the very centre of the inflorescence, a position which it never assumed in the three days during which it remained alive in my hands: it will be noticed in the figures (pp. 840, 841), which are from photographs taken from life at Aring, that the insect is clinging to the edge of a bunch of flowers. The attitude which it adopted did not change with its position in the inflorescence. In all cases, so long as the insect was on the watch for prey, the abdomen was bent backwards until its dorsal surface almost touched that of the thorax. The head and thorax were held upright, and the fore limbs in front of them, in the ordinary "praying" attitude of the Mantidæ. The other two pairs of legs, by which it clung to the flowers, were disposed round the upturned abdomen, more or less at right angles to the main axis of the body. Sometimes this was the same as that of the inflorescence, but often it was at an angle to it; for the Mantis seemed indifferent as to whether its head or one of its sides was uppermost. When once a position had been taken up, it was never changed so long as the insect remained on that particular inflorescence. Perfect as was the concealment thus effected, I cannot say that the Mantis imitated a single flower or part of a single flower with any great accuracy. Perhaps the upturned abdomen might be taken to represent a bud not yet opened, while the darker expansions on the femora showed a greater resemblance to petals which had already unfurled themselves. The petals of *Melastoma*, however, are more elongated than these structures on the legs of the Mantis, which are almost circular in shape, though their diameter is as great as, if not greater than, that of the floral structures which they represent. What I can say with certainty is, that a most marvellous resemblance is produced between the insect *Hymenopus bicornis* and part of an inflorescence of *Melastoma polyanthum* when the flower and the insect are combined, as they sometimes are in nature. I cannot say that they are always found together. An interesting point in connection with this simulation of the flowers is the part played by the green bar across the thorax of the Mantis. This bar divided the prothorax from the rest of the body, and apparently separated the insect into two parts, which appeared to have no connection with one another on the inflorescence. In no ordinary inflorescence of this plant are the flowers large enough to afford an expanse of uniform coloration of the size of *Hymenopus*.

During an unsuccessful search for further specimens in the buffalo-lawn at Aring, the Mantis was placed, together with the inflorescence to which it still clung, in a large box lined with dead leaves. On the lid being taken off from this, after about half an

hour's interval, it was found that the insect had deserted the flowers and was sitting quite still among the leaves at the bottom of the box. Though its attitude was essentially the same as before, its whole appearance was now completely changed; for it no longer resembled the flowers among which it had been found except in the most remote degree, but appeared rather to simulate an orchid fallen upon the ground. The brown lines on the upper surface of the abdomen, which had before been concealed among the petals of the flowers, became conspicuous from many points of view, now that the body was seen from above. Converging as they did towards the junction with the thorax, they bore no slight likeness to the "honey-guides" of many orchids. The darker transverse bars seen in the shadow cast by the head and thorax gave an idea of hollowness such as might be expected round the nectaries; while the abdomen itself represented the labellum, and the limbs the other petals of the orchid. The head and thorax took the place of the stamen and anthers, their resemblance to which was greatly increased by the horn-shaped eyes; and even the green bar on the thorax had a new part to play, for on not a few orchids there is just such a band at the base of this part of the flower. No change of colour aided the change of appearance. The Mantis remained among the dead leaves for the rest of the day of its capture and for the night which followed, without altering its tint or losing anything of its brilliancy. I do not know of any specific orchid which it may have simulated; orchids of sufficient size and brilliancy of colour are rare, if not unknown, in lower Siam.

Early the next morning the Mantis was placed on a packing-case in the open air, near a large branch of the "Rhododendron" fixed upright in a natural position. It deliberately walked towards the branch, swaying its whole body from side to side as it progressed, and commenced to climb one of the twigs. This twig, however, bore only green buds and unripe fruit. When the Mantis reached the tip of the twig and found no flowers, it remained still for a few seconds, and then turned and descended with the same staggering gait. It proceeded to climb another twig. This also bore no flowers. The Mantis descended from it and mounted a third twig, which was topped by a large bunch of full-blown blossoms. To these it clung by means of the claws of the two posterior pairs of limbs. For a few minutes it remained perfectly still, and then began swaying its body from side to side, as it had done while walking. (It was only during this brief interval of rest that I was able to secure a photograph, for in a tropical climate so damp as that of lower Siam instantaneous photography is never satisfactory. The light, in spite of its apparent intensity, is very feebly actinic, and the moisture of the atmosphere combined with the heat makes it impossible to keep "rapid" plates for any length of time.) While the body of the Mantis was in motion the fine hair-like antennæ were also in constant agitation, sometimes being held upright, sometimes stretched out like horns, and sometimes lying back along the thorax.

Almost as soon as the Mantis had settled itself on the inflorescence, a small, dark, dipterous insect, of a kind very commonly seen on the flowers of this species of *Melastoma*, alighted on one of its hinder legs. It was soon joined by others, apparently of the same species as itself. They settled quite indiscriminately on the petals and on the body and limbs of the Mantis. It was then that the significance of the black spot at the tip of the abdomen became apparent, for at the distance of a few feet it was impossible to distinguish it, except by its symmetrical position, from one of these small Diptera. The Mantis made no attempt either to drive off or to capture the small flies, for its motions seemed to attract rather than to repel them. After a short time a larger Dipteron, as big as a common house-fly, alighted on the inflorescence within reach of the predatory limbs. Then the Mantis became active immediately; the fly was seized, torn in pieces and devoured, notwithstanding the presence of a large crowd of natives who had collected to watch what was happening. I did not see *Hymenopus* actually catch an insect on its own person; but very probably this was owing to the short duration of my observations. The smaller Diptera were unable to discriminate between real and simulated vegetable tissue, and there is no reason to suppose that the larger ones are more intelligent. I was unable to detect any secretion from the integument or any part of the body of the Mantis which might have attracted them. It is quite probable that they acted gratuitously as lures for its prey, in that they made it appear that there was no trap set, if they did not form an actual bait for predaceous insects.

After the Mantis had been on the watch for some little time, I noticed that the abdomen was drooping slightly and was gradually coming to lie in line with the thorax. As it did so, the brown lines on its dorsal surface came into sight, and they grew more conspicuous the more it drooped. At last, only a very few minutes after I had first noticed this movement, the Mantis gave a sudden leap into the air and alighted on the ground at the distance of several feet from the place where the base of the stem would have been had it leaped from a real bush of the "Rhododendron." It then staggered quietly away along the ground. When interrupted in its progress it gave a short jump; but it was easily recaptured, as its leaping powers were chiefly developed in the direction of jumping to the ground from a height. I was able to watch this drooping of the abdomen and final hasty desertion of the flowers on four separate branches. In each case the process commenced when the flowers began to droop, and occupied, perhaps, two minutes in completion. The drooping of the abdomen was primarily a preparation for leaping. Of that I have no doubt, for the body was bent again the moment the insect reached the ground, almost as if it were brought into position by the action of a powerful spring. Whenever the Mantis gave one of its short jumps on the level, the body was previously straightened with almost the same rapidity of action.

Moreover, the upturned position of the abdomen is common to many Mantid larvæ, for instance those of several species of *Hierodula* and *Pseudomantis*, though in the adults of these forms it becomes an impossible attitude when the insects are at rest, owing to the outgrowth of the wings; and these larvæ have the habit of leaping to the ground when disturbed on the tree-trunks on which they watch for prey, and always straighten their body before they leap. But that this action has a secondary significance in the case of *Hymenopus bicornis* is proved by the deliberate and gradual way in which it takes place when the insect is seated on an inflorescence. It seems to me that its secondary object is to display the brown lines on the dorsal surface, in order that, as the flowers wither, the flower mimic may appear to wither also. It must be remembered that in the tropics the process of fading, in the case of most flowers, is an exceedingly rapid one. It is difficult, however, if this be the true explanation, to see why the Mantis should leap to the ground when the flowers of a single inflorescence begin to fade, for we can hardly assume that it looks round to see whether other flowers on the same branch are fading also, and *Melastoma* is not a plant on which all the blossoms naturally fall off at the same time. In the case when it could find no proper concealment on one twig of a branch, the insect did not behave in this way. It is quite possible that its instinct may warn it to seek for other shelter whenever the petals begin to droop, for flowers of this plant close at night and in very bad weather. Under either of these conditions the insect must find it impossible to get its prey, and may be exposed to death from cold or from the violence of the rain, should it remain in an exposed position. Most probably it takes shelter among the undergrowth during storm and dark. When placed in a dark box it deserted the flowers to which it clung while they were plucked from the bush with considerable violence.

Malay Beliefs.—The Kelantan Malays call this insect "*Kanchong*," but they consider it so rare that my desire to obtain more than a single specimen was ridiculed as being quite extravagant. I was told that few men ever saw more than one such Mantis in the course of their lives. It was agreed at Aring that the *Kanchong* is not a "*belalang*"[1] (the general term in Malay for any Orthopteron which is neither a cockroach, "*lipas*," nor an earwig, "*sipit-sipit*")[2], but a flower which has become alive. "Its origin is from the flowers." The blossoms of the "*Sendudok*" give birth to it, in the same way as the leaves of the "*Nanka*," or Jack-fruit tree (*Artocarpus integrifolia*), give birth to *Heteropteryx dilatata*, a large prickly Phasmid

[1] *Belalang* are named after the *Lalang* Grass (*Imperatia koenigii*), which affords a favourite shelter to many orthopterous insects.

[2] *Sipit* are the tweezers with which the Malays pluck out the few hairs that naturally grow upon their chins. The reduplication of a word in Malay either gives it a metaphorical sense or turns it into a plural of indefinite multitude. Thus, *mata-mata*, from *mata* an eye, means a policeman; *macham* is a kind or sort, *macham-macham* all sorts.

of great rarity which rich men keep alive in cages in order to secure its eggs, which they set in rings like jewels, and consider to be a most powerful charm against evil spirits of all kinds. These eggs are said to be of a beautiful red colour.

Remarks.—Professor Poulton has been kind enough to show me some young larvæ of *Hymenopus bicornis* that he has lately received from Mr. Shelford, Curator of the Sarawak Museum, Borneo, together with some Heteroptera to which they bear a very close and detailed resemblance. It is indeed remarkable that any animal should be so highly specialized in two different directions of deception during the lifetime of an individual. The imago of this form, judging solely from dried specimens, may possibly show a likeness in life to a withered flower. Its long white tegmina, with their faint brown markings, may well have this appearance in life, if they are possessed of the flower-like glistening which distinguishes certain parts of the body of the pupa.

The pupa of the Indian Mantis, *Gongylus gongyloides* [1], the habits of which have been described by Dr. J. Anderson, resembles the *Kanchong* in swaying its body while waiting for prey, but differs from it in that only the lower surface is coloured like a flower, the back being green, and that the flower-like shape is brought about by the expansion of the thorax. Two varieties of the pupa of *Hymenopus* itself are known: the one is pink, the other white. Any information as to whether these are seasonal forms, whether they confine themselves to the flowers which they resemble, and whether they are in any way modified by light reflected from their environment, would be of the very greatest interest. Wood-Mason reports [2] two specimens, the one white and the other pink, taken at an interval of six months, apparently from the same district, in Assam. Mr. R. L. Butler of Selangor tells me that he has taken white specimens, and white specimens only, on the verandah of a bungalow at Kuala Lumpur, on which white lilies were growing in pots. Wallace [3] says that in India the pink variety will settle among any flowers or leaves, and he seems to lay stress on this point in a note which I have received from him. In the figure [4] of this insect given in Poulton's 'Colours of Animals' (p. 74) it is represented as sitting head downwards, on a leaf, with the abdomen and thorax in a straight line; in all of which points the attitude of the specimen depicted differs from that of mine, though the first is of no great importance. The brown lines on the dorsal surface of the insect [5], and the dark spot at the tip of the abdomen, are entirely omitted by the Indian artist. My specimen certainly refused to sit among leaves when it was in

[1] P. Asiat. Soc. Bengal, 1877, p. 193.

[2] Ent. Soc. London, 1877, p. xxix.

[3] 'Darwinism,' p. 212.

[4] The figure is from a native drawing sent to Wallace by Wood-Mason, from whom the information about this insect in 'Darwinism' was also obtained.

[5] These lines, and also the black tip to the abdomen, are just as conspicuous, judging from dried specimens, in individuals from other parts of the East as they were in the one observed at Aring.

the light; and I am sorry that I did not experiment with other flowers than those among which it was found. It would have been exceedingly difficult, if not impossible, to find any of sufficient size in the immediate neighbourhood of Kampong Aring.

Hymenopus bicornis, the only representative of its genus, is an insect which has a fairly wide distribution, being found in Sikkim, Java, and Sarawak; but in none of these localities does it appear to be at all common; in Kelantan it is exceedingly rare. During the six weeks which the expedition spent at Aring, only one specimen was seen, though every clearing in the district was full of the blossoms of the *Sendudok*. It may be said that an animal so well able to hide itself might easily exist in considerable numbers without being detected. This would have been perfectly true had the Mantis been in the habit of sitting still; but movement in an apparent flower is just as attractive to a biologist as it is to a lizard. After the first specimen had been captured, hundreds of bushes were examined with the very greatest care by three zoologists and a botanist, but no *Hymenopus* was found. Granted that the insect is as highly specialized in instinct as it is in form—and I think there can be little doubt that this is the case—it is not difficult to suggest an explanation of its rarity. It is an animal which, for some reason, has had the greatest difficulty in holding its own in past ages, and it has been driven in the course of its struggle for existence to the extremes of specialization. It has become so highly specialized, in fact, that it has condemned itself, as it were, to a single and very limited environment; and should that environment be changed, even to a slight extent, by external circumstances, the insect must either perish or alter both its structure and its habits immediately, a thing which no highly-specialized animal is likely to do rapidly. Now in the Malay Peninsula the conditions of life are always undergoing small changes that are apparent even to a traveller hastening through the country; there must be many that years of research could not reveal. Suppose that the district of Aring were decimated by the small-pox, as many a Malayan district has been, and that the inhabitants who survived fled over into Pahang with their buffaloes, in a few years the jungle would kill off all the Sendudok bushes in the neighbourhood, for the plant can only exist in a clearing. In olden times, before the advent of the Malays into the Peninsula, the Sendudok must have been a rare plant in Kelantan, as neither the Sakais nor any of the other aboriginal tribes make clearings or keep cattle. The extremely local nature of the fruiting-season of various semi-cultivated trees, such as the Mangosteen (*Garcinia mangostana*), must have some influence on the insects of the different districts, and seems to depend not so much on local variations of climate as on the different varieties of the trees that are popular in the different villages. One would like to know whether the variations of a fruit of such ancient cultivation as the banana affect the insects which live upon it. In lower Siam over a hundred varieties of

this fruit are said to be commonly grown, differing from one another in shape, size, colour, and even smell; and it is often the case that in two villages separated by only a few miles the predominant variety of banana is different. The introduction of a foreign weed such as the "*Putri Malu*," or Shy Princess (*Mimosa pudica*), among the teeming insect population of a tropical clearing must have some direct effect upon the life therein, and indirectly must influence all the surrounding country. This plant has appeared in the Peninsula since the arrival of the white man, its natural home being South America; and has succeeded in becoming one of the commonest and most noxious weeds in the country, even in the districts to which the white man himself has not yet penetrated.

III. Another Harpagid Pupa.

Colour.—Head: pink, eyes and mandibles black. Antennæ black.

Thorax: prothorax, which is broad and slightly flattened, dull pink, striped transversely with dingy white and pale green, and edged with black. (There is no bar on the posterior edge of the prothorax as there was in the other form.) Posterior region of thorax dull pink. Rudimentary wings dingy white, with a pale green band at the base of each.

Abdomen: pale pink, ringed with pale green, dingy white, and black. The green and black rings did not completely encircle the body, but were interrupted in the mid-ventral line by a number of prominences, one to each segment, of pale pink. At the extreme point of the abdomen, surrounding the anus, was a black spot, not so large or so prominent as the one on the corresponding position in *Hymenopus bicornis*, but still conspicuous.

Limbs: all the limbs were ringed with bands of dingy white, pink, and green, which completely surrounded them, including the expansions on the femora of the 2nd and 3rd pairs. The spines on the predatory limbs were some of them green and some black. The black spines predominated towards the distal extremities.

This Mantis had none of the flowery sheen of the other, and the lappets on the 2nd and 3rd limbs are small, rounded, and in nowise petal-like. The flowers with which it was found associated were of a deep cream-colour. Their buds and leaves were considerably darker than the green markings on the insect's body.

Habits and Attitude.—Unfortunately I was unable to observe this species in a state of nature, but I have no doubt that its habits are very similar to those of the Kanchong. The natural attitude of the two species is precisely the same, and though they adopt different methods of concealing themselves, they were both found hidden among flowers, presumably for the same purpose—that of obtaining their food. The common possession of a black tip to the abdomen is interesting. A single specimen of the striped Mantis was brought me on August 19th, by Mr. R. H. Yapp,

then botanist to the Expedition, together with a spray of the flowers and leaves of an acacia among which he had found it. The flowers of this tree are very much like those of the common Mimosa, but larger in size and of a far less brilliant shade of yellow. The leaves are much divided. Mr. Yapp tells me that he found the specimen on a tree near the edge of a buffulo-lawn across the Kelantan river opposite Aring, about eleven o'clock in the forenoon. Even in the dim light of the mosque in which we were then staying the insect was very inconspicuous among the flowers; and when it was taken out into the brilliant sunshine it completely disappeared among the shadows cast by them and the leaves. The dark bars on its body and limbs were slightly wider than the spaces between the pinnules of the acacia-leaves, and the prominences on the ventral surface of the abdomen were of the shape, though not of the colour, of the prominent parts on the unopened flower-buds; for it will be noticed that the buds were green, while the structures on the insect's body were pale pink. These prominences were conspicuous; but the lights and shadows among the feathery leaves and fur-like flowers were so confused that a difference in colour detracted little from the similitude between the abdomen, cut into as it was by the black bars which were conspicuous on its edges but interrupted in its middle line, and the distal extremity of one of the racemose inflorescences of the acacia.

The insect and the flower had not a single colour in common intrinsically; and yet, under given conditions of climate, the colours of the two became indistinguishable from one another.

The Malays at Aring called this insect Striped Kanchong; but the name was evidently invented for the occasion. The plant on which it was found being a tree and not a shrub, it was much more liable to escape detection, even had the acacia been as common as the "Rhododendron." There are plenty of similar acacias in Kelantan, and there is no reason why the Mantis should confine itself to one species, for its colour and form are adapted for concealment among any flowers and leaves of this peculiar type. The possession of leaf or petal-like expansions on the limbs is a peculiarity shared by many Mantids with leaf-like insects of different groups, but as a rule their outline is not so regular as it is in the case of this species and of *Hymenopus*. With regard to the origin of such structures and their primitive function, it is worth while noticing their rudimentary condition, whether it be a specific or merely a pupal character, in forms like this Striped Harpagid from Kelantan. It cannot be said that in this case they give any direct aid in concealing the insect by resembling petals of a flower or any other vegetable organ. But, especially where we get the extremes of light and shade, any little irregularity of outline or projection from the surface of the body of an animal may give it a distinct aid in hiding itself. This is truer in the case of the smaller invertebrates than it is in that of vertebrates, though the principle is well exemplified by many fish, and not a few lizards, that live among terrestrial and aquatic plants. A large nocturnal

snake, like the "*Ular katam tebu*" (*Dipsadomorphus dendrophilus*)[1] gliding among mangrove-roots beneath the moonlight, or a tiger resting at midday in the *Lalang* grass, is well concealed by its colour gradations and its black and yellow stripes, and has no need of an elaborately foliated tail like that of a heraldic lion; such a tail might be of very great advantage to a small Arthropod. Repeated observations, more especially in the small caves of the Koh Sih Hah, or Five Isles of the Tale Sap, have convinced me that the extreme elongation of the spinnerets in the Araneid family of Hersilidæ—the "*laba-laba berekor*" or tailed spiders of the Malays—aids greatly in effecting their concealment on the grey stones and tree-trunks which they frequent, by breaking the otherwise smooth and rounded outline of the abdomen, as the long legs break the outline of the cephalothorax. In short irregularity of outline bears much the same part in hiding an animal as does irregularity of colour such as is exemplified by the black bars on the otherwise pale and inconspicuous tints of the striped Mantis.

But irregular protective colour is by no means confined to definite bars and stripes, which might be said more exactly to represent definite shadows or spaces; it possesses even more frequently a scattered or speckled arrangement. In fact, it is very often the case that the actual colours present are not of such great importance as the manner in which they are arranged and their multiplicity in a given space. It is well known that even in the ordered light and surroundings of a picture gallery, if sufficient brilliant colours are crowded into a sufficiently small space they "kill" one another and are no longer brilliant. This is doubly true in the deep gloom of the jungle, where any colour has the greatest difficulty in asserting itself, and where so many hues that are in themselves brilliant have to contend with one another. On the jungle floor almost all colours are present in small quantities; there are patches of deep blue where the sky is reflected through a crevice in the upper foliage upon rain-water held in the hollow of a dead leaf; among the dead leaves themselves there is every shade of brown and yellow, and scattered black and white in plenty; patches of scarlet caused by fungi on rotten wood are sometimes frequent; there is the brown-pink of the seedlings struggling towards the light; and the dull green of tree-stems and creepers, and of the ferns and the few phanerogams which are adapted to exist down below. Bright green alone is absent, except in some

[1] *Katam tebu* are little round pieces of sugar-cane from which the outer skin has been removed. They are sold in the markets on bamboo skewers. The term "*Ular Katam Tebu*," in the Siamese States at any rate, is generic, and is applied to all snakes, whether marine or terrestrial, which are conspicuously ringed and which are too big to come under the category of "*Ular Kapak*" or Axe-snakes; the dark skin of the reptile being taken to represent the spaces between the *katam* on the skewer, and the lighter rings the *tebu* or sugar-cane itself. *Dipsadomorphus* is by far the commonest of such snakes, and therefore the species with which the name is most generally associated. In other parts of the Peninsula it is probable that the "*Ular Katam Tebu*" is *Bungarus fasciatus*.

mosses of the minutest size; so that large Locustids of yellows green, *Pseudophyllus* and others, which in the cabinet, and perhap- in their own place, form such admirable imitations of bamboo-leaves in colour, and to a lesser degree in form also (for doubtless they are part of the *plancton* of the jungle, and only gravitate down into its depths by misadventure), are the most conspicuous of the smaller jungle fauna which one meets with below. Yet all these shades are so altered and commingled in the chequer of deep shadow with occasional gleams of sunlight that they become completely confused to the eye. One is tempted to speculate as to whether the gorgeous tartan-like checks in which the Malays are so fond of clothing themselves may not have originally developed among a jungle-loving and somewhat murderous people at constant feud with their neighbours, as a means of secondary protective coloration, and have become more brilliant and less useful through the vagaries of sexual selection. On festive occasions these combinations of many colours are chiefly worn by the men, the women preferring for their holiday dresses simpler and more striking costumes into which only four or five masses of colour enter as a rule. On the jungle floor itself the most inconspicuous animals are certain long-legged but by no means bulky Phalangiids, which appear and dis- appear as they move or are still. Intrinsically they are of brilliant colours; one species is black, speckled on the body and limbs with scarlet, white, yellow, and green. But they are less conspicuous even than the majority of Phasmids found in similar situations, even than the forms which have green markings resembling minute liverworts, such as cover the stems and leaves of the jungle flora, on their otherwise stick-like bodies; for it is generally easy to distinguish the exact outlines of such insects if they have once been located; but even when the Phalangiids are moving it is rarely possible to see either their limbs or their bodies, though their motions are perfectly visible. Every such stick-insect resembles a particular stick, an ideal stick it is true; the Arachnids are assimi- lated, not to any particular object, but to their surroundings generally, by their irregular colour, their irregular form, and by the large extent of their surface in comparison with their bulk. The limbs of the Phasmids are often held in angular vegetable attitudes, but they do not always blend into their environment as the almost hair-like legs of the Phalangiids do; for it is often the case that the instinct of the insects is at fault in the choice of their immediate surroundings[1], whereas the protective adaptation of the Arachnids, being general and not particular, does not necessitate any high specialization of instinct to accompany it.

But that the object of brilliant coloration arranged in stripes is not always the same, even in a single group of insects, is proved, if proof were necessary, by comparing the striped pupa from Aring with the Arabian and African imago *Idolum diabolicum*[2], a form of which the natural colour and attitude have lately been described

[1] See Proc. Roy. Phys. Soc. Edinburgh, Dec. 1900.
[2] P. Cambr. Phil. Soc. vol. x. p. 175 *et post.*, plate ii.

by Sharp. This latter insect makes no attempt to conceal itself, but sits among leaves, showing, by reason of its broadened thorax and coxæ of the first pair of limbs, a likeness to some gorgeous flower.

In connection with these flower-like Mantids it may not be superfluous to mention the leaf-like form, *Deroplatys trigonodera*, which is sometimes found in the deep jungle near Aring. Though the whole visible surface of this species, including that of the tegmina and of the legs, is coloured like a dead leaf [1], and though the tegmina, the thorax, and the two posterior limbs bear irregular leaf-like processes, yet the posterior wings, where they are concealed by the tegmina, are coloured deep maroon, veined and rimmed with white. A specimen which crawled up my leg from the jungle floor made no attempt to fly when captured, but defended itself with its armed predatory limbs, drawing blood from my finger. Very possibly this species also may be nocturnal, or at least crepuscular, and only use its wings in the evening. This is certainly the case with the various species of large green Mantidæ that are common through the whole of lower Siam. At Biserat, in the State of Jalor, specimens of *Hierodula modesta* flew into our verandah in the evening on several occasions, and settling on the whitewashed wall, would feed on the termites and small Orthoptera attracted by the lamp, they themselves showing no inclination towards its flame. The insects which they caught did not avoid them in any way, but walked straight into their clutches. The larvæ of *Hierodula* and allied genera are often to be seen sitting on tree-trunks in the middle of the day; but I never observed an adult on the wing before sunset.

Ceratomantis saussurei is another interesting Mantis which may be taken at Aring. The head, body, and limbs of this species are of a dingy yellowish grey, speckled with black. The wings, which are unusually broad, are transparent, but the tegmina are marked with curious black streaks. The head is prolonged forwards between the eyes into a peculiar spike. The predatory limbs are broad and flattened dorso-ventrally; and the sides of the abdomen are produced into several irregularly shaped lobes. On the inner surface of the fore leg, which is concealed by that of the opposite limb except when the insect is struggling with its prey, there is a black bar running along the femur.

One morning in September, I found a specimen of this Mantis at Aring in the interior of a fallen tree which I was chopping up in the jungle. The wood was rotten and afforded a harbour to many other insects, such as beetles and cockroaches. A few days earlier another specimen was brought me by a Malay, together with a dead Selaginellid among which he had found it. If this Mantis is seated among the dead wood, its colour makes it inconspicuous; but if it is among dead fern-fronds or withered Selaginellids, its predatory limbs entirely disappear, owing to their

[1] Numerous other species of the same genus are coloured in a similar fashion.

colour and form. Among these leaves, the head and wings, though they are inconspicuous, are not invisible; the wings may be detected because they are transparent and glary, the head because it is held well raised above the surface on which the insect is sitting. Seen in such surroundings, there is nothing that would lead a human being to judge that the Mantis was a predaceous animal. Indeed, it bears a general likeness to a moth or a non-predaceous Neuropteron, not particular enough, perhaps, to justify one in saying that it "mimics" any other form, but sufficiently marked to deceive one as to its real nature. The fact that a specimen of the Mantis was found concealed in a dead tree would lend colour to the idea that it is nocturnal, as a large proportion of the Mantidæ appear to be. But it is quite possible that it may be sufficiently active in the daytime to seize any prey which comes within its reach. If so, it affords an instance that may be compared with that of the Kanchong. While the latter simulates a flower, and so actually allures its prey, the former sits still and looks harmless, so that its prey chances to come to it uninvited. The difference seems to me to be one of degree. Supposing that a green Mantis were seated among leaves of the same colour as its own body, and that a phytophagous insect alighted upon it, it might then be said to be an instance of "alluring" coloration. Whereas if the insect only alighted near it, the Mantis would scarcely come under this category. In any case the adaptation appears to be calculated to deceive Arthropod prey rather than mammalian enemies. The Mantidæ are well adapted for self-defence, and the movements of the Kanchong, at any rate, betray the insect to vertebrate eyes.

The curious prolongation of the head in *Ceratomantis* is not a feature of any systematic value; many other Mantids, belonging to widely separate genera, have a similar peculiarity. Undoubtedly, however, in this case it aids in masking the characteristic shape of the Mantid head; or, at any rate, appears to do so.

With regard to the marking on the femora of the fore limbs, similar markings, often emphasized by yellow lines running parallel to them or across them, occur in the same position in a large number of Mantidæ. I do not know that a function has ever been assigned to marks situated in this position except by the Russian naturalist Porschinsky, whose interesting observations [1], and imaginative explanations thereof, Professor Poulton has been kind enough to have translated for me from the Russian. Porschinsky has a theory that all eye-like markings on insects represent glands, which may be imagined to excrete a noxious fluid. He supposes that such markings simulate the liquid which has issued forth, with the blue sky or some other object reflected in it. He points out that the display of such spots is sometimes accompanied by a sound which might be taken to imitate liquid hissing out of a narrow opening such as the duct of a gland. *Mantis religiosa* is one of his examples. He says that there is a large

[1] Lepidopterorum Rossiæ Biologia, iv. (Petersburg, 1893), p. 36, fig. 10.

blue "eye" ringed with black on the inner surface of the femur of the fore limb in this species; and that the "eye" is concealed when the Mantis is at rest, because the two limbs are held folded together in front of the body. "But when danger threatens," to quote his own words, "the praying Mantis assumes a very peculiar and interesting attitude, which, so far as I know, was first described by Goureau. The long and narrow prothorax assumes a vertical position, so that the body is supported only by its two pairs of hind legs. Under these circumstances the insect widely separates the front pair of legs, giving to its long femora a horizontal position, so that the distal ends of them are directed on opposite sides. In this way the eye-spots, which are situated at their bases, stand out conspicuously and are most obvious, owing to their colour. The tibiæ of the front pair of legs are directed vertically upwards. At the same time the insect lifts up its tegmina and unrolls its wings, giving them a horizontal position, and it begins quickly to raise and lower its abdomen, which, rubbing against the posterior edge of the wings at the same time as these continual movements, produces a sound. The Mantis can produce the latter artificially by rubbing its wings against some extraneous object."

In the 'Entomologist's Record' for January 1900, Brunner von Wattenwyl calls attention to the markings on the fore limb of a species of *Hierodula* from Borneo. He speculates as to their origin, but does not assign them a use.

IV. Alarming Colour and Attitude.

A Hooded Locustid (*Capnoptera* sp. n. near *C. staudingeri*).

Colour.—♀. Body and limbs dull green, marked with dark brown. Tegmina dull green, veined and spotted with dull blue and marked with black. Hind wings pale smoke-colour. Between the head and the thorax there is a rectangular bladder of vivid scarlet. This is habitually concealed beneath the dorsal plate of the prothorax, but can be everted and project behind the head like a hood. When not in use the two corners most remote from its point of origin are inverted. When it was displayed these were everted, apparently by the forcing of blood into the hollow of the structure. ♂. Similar to female, but considerably smaller. The hood was equally well developed in both sexes.

Habits and Attitude.—The species is not uncommon in the jungle of Nawnchik, Patalung, and Jalor; but the male is much rarer than the female. I only obtained a single specimen of the former. So far as I know, there is nothing peculiar about the habits of this species when it is left to itself, except that the saltatorial legs being less highly developed than they are in most Malayan Locustids, it is unable to take the enormous leaps of forms, like the "*Belalang Rusa*" or Deer Grasshopper (*Mecopoda*), which are found in the same environment. When the hooded locust is taken in the hand it makes very little resistance. Leaving the consideration of its peculiar means of defence for a moment, this

is not surprising, as the chief resistance that the ordinary large Locustid can offer is that performed with its third pair of legs, which are incredibly powerful in some species and often armed with formidable spines. Instead of resisting, it lowers its head, so as to separate it from the thorax, and erects the hood. If this does not cause its enemy to let it loose, its resources are at an end. The sudden apparition of the vivid scarlet patch on the dull and inconspicuous body of the insect may well be disconcerting to its natural enemies. To a human observer it appears that he has injured his specimen, and that some brilliantly coloured portion of its internal anatomy is issuing from its neck.

Malay Name.—The Jalor and Rhaman Malays call this and allied species "*Belalang Gambor*," or Image Grasshopper, perhaps because they recognize a likeness between it in its alarming attitude and images of Buddha overshadowed by Cobras with expanded hoods. A colossal statue of this kind exists in a cave-temple near Biserat. When I asked for the "*Belalang Gambor*" at Aring, the natives brought me a large Locust (*Acridium succinctum*), that is known to the Malays at Biserat as "*Belalang Babi*," or Pig Grasshopper.

Remarks.—In the jungle near Kota Bharu, Rhaman, I found a single specimen of another species (*Capnoptera*, sp. n.) which had the same peculiarity of structure and attitude as this form, but differed from it in that the brilliant coloration was not confined to a part of the body which was concealed when the insect was at rest. Its head and body were of a dull neutral green; its tegmina pale, dull translucent yellow, barred and spotted with black; and its legs magenta. Magenta was also the colour of the hood, which in form and extent resembled that of the commoner species.

The action of these two grasshoppers may be compared with that of certain caterpillars, *e.g.* of one which is not common on pomegranate trees at Biserat in the month of June. It is a fair-sized form, probably belonging to the *Lymantriidæ*, which reaches a length of from 4 cm. to 6 cm. The dorsal surface is covered with long hairs of a pale lemon-yellow colour, those on the 4th to 7th segments being shorter and more closely set than the others. Between the 4th and 5th segments a black bar of a peculiar velvety appearance extends right across the body. This bar is surrounded by a kind of white halo, and is almost completely concealed when the caterpillar is feeding or walking; which it does in rather a peculiar manner, always resting after every few paces, and twisting its body about, as if it were feeling round to see that there was nothing wrong. If one blew upon the caterpillar, or irritated it in any other way, it suddenly bent the anterior and posterior regions of its body together, thus causing the black bar on the back to become stretched and be conspicuous, and to appear like a gaping, cavernous mouth, of which the bunches of hair behind and before formed the jaws. The phenomenon was first pointed out to me by Mr. D. T. Gwynne Vaughan, then botanist to the Expedition.

Some such cases come near to mimicry; for the one just

mentioned differs but little in essentials from that of the Sphinx larvæ, which bring into prominence the eye-like markings on their sides when alarmed, and thus seem to mimic small reptiles or mammals. One such caterpillar[1] is not uncommon in Nawnchik and Patalung during April. It feeds on a species of *Caladium*[2] growing in marshy localities, and is generally found on the underside of the broad leaves, in the shadow of which it may easily be mistaken for a small gecko which has lost its tail; though geckos do not live in the marshes, and though its eye-spots are perfectly round, more like the eyes of a snake than those of a gecko in the daytime.

In some cases structures which are alarming at one stage of an animal's existence may be mimetic or protective at another. The case of the larva of our English Lobster Moth (*Stauropus fagi*)[3], which in its youth is said to mimic an ant, is so well known that I need only refer to it. In lower Siam there is a common caterpillar, of what family it is impossible to say, which has a series of curious long, flattened processes rising in three rows from the dorsal surface of the anterior part of the body. When the animal is walking these structures are kept in constant motion. They may be supposed to alarm its enemies by their movements, and certainly they give the full-grown caterpillar no aid by concealing it or by making it resemble any other animal. But I have been completely deceived by a very young specimen of this form. It was hanging by a thread from a tree, and looked so extremely spider-like as it hung, that I captured it to add to our collection of spiders. Nor was I undeceived before the insect was in my spirit-tube; for in the Malay jungle there are many Araneids with elongated abdomens.

An animal which is habitually of an alarming appearance may even lose this appearance periodically. At Aring, one afternoon in the beginning of September, a caterpillar nearly allied to *Stauropus fagi*, and probably belonging to the same genus, came under my notice. When first I saw it I mistook it for a bird's dropping. It was seated on the edge of a leaf of *Melastoma polyanthum*, with the anterior and posterior regions of its body bent towards one another, with the true legs folded together upon the under surface of the thorax, and the abdominal feet firmly clutching the edge of the leaf. The body was bent over so that one side lay on the upper surface of the leaf, parallel to the mid-rib. The insect was motionless. Its skin was smooth and shiny; intense black in colour, except for some vivid white markings about the middle of the body. The likeness to a bird's dropping was not exact, because these white markings were at the

[1] The Malays do not appear to have any superstitious dread of this caterpillar, such as is felt by the Irish for that of the Elephant Hawk Moth (*Chærocampa elpenor*), a form to which it bears a close resemblance. For the Irish beliefs with regard to the caterpillar, see Miss Ormerod's Reports, 1898, pp. 72–73.

[2] The "*Kladi mabok*" or Sick Caladium, so called because, unlike some other species, it is inedible.

[3] See Poulton, Journ. Linn. Soc., Zool. xxvi. pl. 40, and 'Colours of Animals.'

centre and not towards the periphery; but, nevertheless, it was striking and, at a first glance, quite deceptive. When disturbed the caterpillar commenced to walk along the leaf, slowly and irresolutely, unbending and rebending its long thoracic limbs as it moved, and shaking the two processes with which its abdomen terminated. I took it home, and shut it up till the next morning with a supply of leaves, hoping to photograph it when the light was better. During the night the insect cast its skin, and in the morning all likeness to anything else had left it. The skin was no longer polished and glittering, and the colour had changed to a dull brown with dingy white bars. Moreover, all sluggishness of movement had disappeared, and the caterpillar was now exceedingly brisk, behaving very much as a well-grown specimen of our own English form would do. During the languor and dangerous inactivity of the ecdysis and the period immediately preceding it, protective coloration had been assumed; as soon as the operation had been safely performed, the habitual means of defence were adopted once more.

But to return to animals which, being otherwise inconspicuous, have the power of exhibiting brilliant colour when alarmed. This phenomenon is not only exemplified by insects. A good instance is that of the Toad *Callula pulchra*, which is found not uncommonly in the Siamese States, among the rubbish which collects under the houses and in like situations. In this species, the upper surface of which is otherwise of a warm brown colour, a broad yellowish stripe runs along either side of the back; but the peculiar looseness of the skin and the folds into which it naturally falls prevent this stripe from becoming conspicuous. When the animal is disturbed, however, it draws air into its lungs until its body becomes almost globular, and the skin is stretched in such a way that its contrasting colours are displayed to their best advantage. We may compare this amphibian to the fish of the genus *Tetrodon* and others, which have earned the name of Balloon-fish among Europeans, and of "*Ikan buntal*," or Pillow-fish, among Malays, by the manner in which they gulp down air into their stomachs, so causing the brilliant coloration of many of them to become conspicuous, and also the spines with which they are armed to be erected.

Another interesting example is afforded by the Lizard *Liolepis bellii*, which the Malays call "*Biawak Pasir*"[1], or Sand Monitor, and which is common in all sandy plains where the vegetation is scanty in the north of the Malay Peninsula. The male of *Liolepis* is coloured in what sounds a very gorgeous fashion, and what is in nature by no means a conspicuous one. The upper surface is grey, mottled and eyed with green, the lower surface pale yellow veined with blue, which is more conspicuous on the underside of the thighs and the neck than on the rest of the body. Along each side there are a number of transverse bars, alternately of orange

[1] "*Biawak*" is the Malay name of *Varanus*.

and of deep purple. The female is very like the male, except that she is smaller, that her colouring is not so brilliant, and that the blue markings are almost entirely absent from her under surface. When the Lizard is running about the sand its brilliant shades are not conspicuous, for the lower surface is hidden beneath the body, and the bars on the sides are almost concealed in the folds of loose skin which are present in the living specimen. *Liolepis* is exceedingly timid and very agile; as a rule one does not see it until it commences to run away, at the distance of several yards. It lives in burrows, which it excavates, so the Malays say, by means of its feet and its snout. When one of the males is taken in the hand, it attempts to bite, for it has sharp teeth and a strong jaw, and struggles violently. As it struggles, it flattens out its body, by enlarging the lower angle formed by the ribs with the vertebral column, so that the purple and orange stripes on its sides come into view. The female tries the same tactics, but without such great effect, for in her case neither are the stripes so brilliant nor the ribs so mobile. It is very possible that the male makes some display[1] before the female at the time of courtship. The Malays say that the "*Biawak Pasir*" is monogamous, and on many different occasions, at Biserat and elsewhere, children brought me two specimens together, male and female, which they said they had snared in a single hole. The case of the Lizard is not quite parallel to that of the Grasshopper, for it is evident that in

[1] That reptiles do indulge in nuptial dances is proved by the case of the "*Sumpah-sumpah*" (*Calotes versicolor*), a Lizard whose great powers of changing its colour have caused the colonists of the Straits to misname it the Chameleon. When the male is courting the female, he is of a pale yellow colour early in the day, though in the afternoon he appears to become slightly darker; and he has a very conspicuous black patch[a] on either side of the throat which calls attention, as it were, to the gular pouches, that he is constantly inflating. He posts himself on some conveniently conspicuous perch, such as the top of a fence or a banana leaf, with his tail stretched out behind him and his fore-quarters raised as high as possible upon the legs. The head is held very erect, but is constantly being nodded up and down, very much in the same way as that of a cock pigeon is nodded under similar circumstances. He opens and shuts his mouth continually, as if he were chattering, but no sound is emitted; it is probably this habit which has given the Lizard its Malay name, which seems to be connected with a word (*sumpah*) that means to curse. In this manner the male advances gradually towards the female, only progressing a few steps at a time. The female remains concealed during the performance, which often commences at a considerable distance from her retreat. I found on several occasions that if one male was killed while dancing, his place was taken by another before many hours had passed. If he was captured, the black spots disappeared from his throat immediately; but they reappeared after death. The males of this Lizard are extremely pugnacious, and when they are fighting together they change colour repeatedly, the victor usually assuming a reddish tinge. The females differ from the males in most species of this genus in that the gular pouches and the nuchal and dorsal crest are smaller than in the other sex; also they do not seem to have the power of colour-change so well developed.

[a] See also Capt. Stanley Flower's paper on "The Reptiles of the Malay Peninsula and Siam," in the 'Proceedings' of this Society, 1899, p. 641. My observations were made in Bangkok, Singora, and Patalung, in the months of March and April.

the former the exhibition of brilliant colour is primarily a sexual attraction, being better developed in the male than it is in the female; but it seems probable that even in *Liolepis* any excitement may cause a display, and that in a secondary manner this display has come to be used as a means of alarming enemies, though it will be noticed that the conspicuous stripes are not exhibited suddenly, or immediately on disturbance, but only when the animal is handled. Also it is strange if the larger, more active male has this means of defence better developed than the female, which must be much less agile at times. The fact that *Liolepis bellii* has particularly strong teeth and jaws does not seem to me to be of any importance in considering the case. The Cobra affords one of the best instances of alarming coloration and attitude, and it happens to be a particularly venomous animal; but there are instances of similar display among animals which have no such dangerous qualities.

The black-and-yellow Snake, *Dipsadomorphus dendrophilus*, which is the commonest large Snake in Lower Siam, when driven to extremities exhibits movements which may be compared with the sudden display of colour by other forms. If a specimen of this Snake is tied up so that it cannot escape, it raises its head, gapes, hisses, strikes wildly at anything that is held near it, and drums spasmodically upon the ground with the last few joints of its tail, thus producing a curious noise. But I have never seen it bite, even when a stick was held close to its mouth; though many Snakes, e. g. *Coluber tæniurus*, will snap at anything, even at their own bodies, when they are sufficiently enraged. The Malays say that *Dipsadomorphus* is not poisonous; but they are much afraid of its bite, because of its violent appearance.

V. Sounds produced by Insects.

A Cicada (*Dundubia intemerata*).

There are two distinct colour varieties of this species, found together and independent of sex; the body of one being grass-green, and that of the other pale brown, which becomes yellow as the insect dries. Among my dried specimens there are intermediate forms more or less mottled; but this peculiarity did not appear for some days after death, and in life all the individuals were either one colour or the other.

At certain seasons this Cicada forms a regular article of diet among the Siamese inhabitants of Patalung; and as their method of capturing it is based upon a knowledge of its habits, I cannot do better than give an account of this method, as I saw in operation at Ban Nah, a village on the border of the hill-country of Patalung. Immediately after the sun had set several of the natives gathered in an open space, round a fire of brushwood or a number of torches fastened to stakes stuck into the ground, and commenced to clap their hands in unison, observing a regular time and rhythm. Very soon, if they were fortunate, the Cicadæ flew

out from the undergrowth of the surrounding orchards and jungle, and alighted on the persons of their captors, who had no difficulty in picking off the insects with their fingers and securing them, still alive, in a fold of their draperies. The clapping only continued for about half an hour every evening, and when, with considerable difficulty, I persuaded the men to recommence it again later in the night, not a single Cicada came near them, though the stridulating had now become loud all over the village, like the noise of machine hair-brushes in a barber's shop.

The insects were silent on the wing, and I only heard one stridulate when caught. The voiceless females, as might be expected, were in great preponderance over the males among the specimens taken; probably the one individual which was not dumb when captured was the only male taken that night. In order to be sure that the fire was not the chief attraction for the Cicadæ, I stood among a party of natives who were clapping, together with another member of the Expedition, who clapped also; while I kept my hands still. In the course of a few minutes, the natives captured many specimens, and ten alighted on my friend's coat; but only one settled on mine. Afterwards I heard from a Patani Malay that the children of Patani town have a game in which they attract Cicadas by clapping their hands, and without the aid of light at all; though they sing, as they clap, a nursery rhyme, calling upon the insects to come down from the trees. The season of the edible Cicada seems to be a very local one in Patalung. At Ban Nah on the 1st of April, and again on the 6th of the same month, the natives secured me as many specimens as I wanted, besides serving a dish of them with our curry on the second occasion. On April 3rd, at Ban Kong Rah, which is only about eight miles further inland than Ban Nah, our guard of native military police were unable to catch a single individual, although they adopted exactly the same method of procedure as the Ban Nah people had done, and clapped at the same time of evening. On none of these three occasions had the moon risen, and in Patalung one night is like another in the dry season. On April 5th, I noticed that the ground in a patch of primæval jungle near Ban Kong Rah was covered with the cast pupal skins of a Cicada. Whether they were those of the edible species or not, I am unable to say with certainty, but they were of the correct size, and, so far as I could see, such as might be expected to belong to this form.

Malay Name, etc.—The Malay-speaking Malays of lower Siam call a Cicada "*Riang-riang*," confusing it with certain large Melolonthid beetles belonging to at least four different species—*Lepidiota stigma*, another species of the same genus, and two species of *Leucopholis*—which buzz round the tops of the cocoanut-palms in the evening, and produce, probably in the same way as the common Cockchafer[1], a sound with a considerable resemblance

[1] See Lubbock, 'The Senses of Animals,' p. 67.

to the word "*riang*" (to call back) pronounced very rapidly and repeatedly. All four species of beetle are on sale for food in the local markets of Patalung, and their grubs, which are found in the earth or under fallen trees, are eaten also. (A conventional representation of the grubs is often carved on rice-stirrers and other objects of household use by the Malays, who call them "*Ulat Kiki*.") Both beetles and Cicadæ are either boiled or fried in cocoanut-oil. The latter have very little flavour of any sort, and what they have is vegetable rather than animal.

Remarks.—The existence of auditory organs in the Cicadæ has not been demonstrated with certainty. The insects must indeed be deaf if they mistake the sound of clapping for the squeaky whirr of the male's stridulation. It is evident, however, that the females have some perception of rhythm, if not of sound. May not this perception be due to vibrations produced in the opercula of the stridulating apparatus? The opercula are often well developed in the voiceless females, though they differ in shape from those of the males. The males, supposing that the perceptive organ were situated in the stridulating apparatus, would be deafened by their own song; as Sharp points out when dealing with Swinton's theory that one of the membranes of the apparatus itself, a membrane which apparently is only present in the male, is an auditory organ. But there is no need for the males to hear their own song, and no proof that they do so. Though only one species of Cicada is attracted by the particular rhythm with which the people of Patalung clap their hands, another rhythm might attract another form. The several species of Cicadæ inhabiting the same country undoubtedly sing in different rhythm [1] from one another. The song of this species is fairly monotonous and unbroken, though it rises and falls to a slight extent. That of the large form *Pomponia imperatoria*, which restricts itself to deep jungle, rises in a series of trills, each of which concludes with a kind of click. Each section of the song is faster, louder, and clearer than the one which preceded it; until, about five minutes after the Cicada's settling, the noise suddenly comes to an end, as the insect flies off to another tree, where it commences again. The sound produced by this species is, at the beginning of the song, like the winding-up of a large clock, and ends by being comparable to the notes of a penny whistle. Another insect, commonly heard at night in the jungle, presumably also a Cicada, has a clear, loud, clarion-like call which can be heard for a great distance.

The sounds in a Malayan jungle after dark may justly be compared to those in the machinery-hall of an exhibition at the busiest time of day, and their volume increases materially before the coming of dawn. The body of the din is the work of small Cicadæ, like the edible species, but the true *riang-riang* and certain Locustids have no mean share in its production. In some places the "Singing

[1] See Riley, Proc. Amer. Assoc. Adv. Science, vol. xxiv. p. 331.

Earthworm"[1], a Gryllotalpid cricket, contributes from its hole in the ground a deep, organ-like note. What is the meaning of all this noise? "The *riang-riang* sing," a Malay would say, "because their livers are glad"; and in many cases we are not in a position to give any better reason. The stridulation of the male Cicada appears to be in the main and primarily a sexual call, but may also be used as a warning or alarming cry.

Of insects capable of producing a sound, some species stridulate when captured, but all do not. The brilliantly coloured little black and scarlet *Huechys sanguinea*, which, unlike the majority of Malayan Cicadæ, is diurnal and flies about among bushes in the open at midday, is silent when handled. The male of the large dung-beetle *Heliocopris mouhotus*, a pair of which was brought to me at Biserat by an elephant mahout, squeaks like a bat when touched, but is silent when lifted from the ground. The female of this species is dumb. On the other hand, many kinds of Orthoptera only stridulate when they are left in peace and quiet. In the Malay Peninsula the majority of stridulating species are nocturnal, or only sing at sunset and just before sunrise. There one does not hear the noise of grasshoppers among long grass at midday as one does in this country, though in the jungle there is a subdued hum of insects continually. At Belimbing in Legeh a man brought me several specimens of the "*Belalang Rusa Ijou*" or Green Deer Grasshopper (*Mecopoda elongata*). Each specimen was in a small bamboo-cage, as he said that if two were put together they would fight. He told me that children kept this grasshopper as a pet, feeding it on the young shoots of the pineapple, in order that they might hear it "crow." My specimens were silent all day, and all the evening while the lamp was lit; but in the middle of the night we were awakened by their stridulations.

VI. Insect Luminosity.

An Aquatic Lampyrid Larva.

Form and Colour.—The body is elongated and narrow: the head is minute, and can be retracted within the thorax. There are eight abdominal segments, which are little differentiated from those of the thorax superficially. The upper surface is corrugated. The colour is dark brown, minutely marked with dull yellow in some specimens. The luminous organs were situated in two small oval patches on the under surface of the last abdominal segment, just behind the anus.

Habits.—On March 30th, when catching fire-flies by the side of a marsh at Lampam, the chief town of Patalung, I noticed a number of luminous points on the surface of a small stagnant pool. We had some difficulty in ascertaining the origin of these, for they died away slowly when the water was disturbed; and it was not until we examined some of the plants floating on the top of the

[1] See 'Oxford Magazine,' Oct. 17th, 1900, p. 9.

pool that we discovered that the light proceeded from beetle larvæ, which were clinging, dorsal surface downwards, to the floating fronds of a small cryptogam. The luminous points were blue in colour and very brilliant, though small. They did not flicker like the lights of the fire-flies which flitted in hundreds over the surface of the marsh, and when they were extinguished they died away gradually. In the pool they did not change their position, but they became sometimes brighter and sometimes less bright slowly, occasionally dying out entirely for no apparent cause. When the larva was taken out of the water, its luminosity disappeared, and did not reappear until it had been restored to its habitual element for some minutes. The light of some specimens which were placed with water and weeds in a glass jar, and brought near a lamp after they had recovered from their capture sufficiently to shine again, went out. After a longer or shorter interval of rest near the lamp, on different trials, it reappeared again. Poking them with a twig sometimes caused them to shine more brightly, but more often to become entirely dark. If several individuals were in a bottle and one of them became brilliant from any cause, the others followed suit after a few seconds. A specimen which was put into corrosive solution ceased to be luminous, but after about a quarter of an hour became exceptionally bright. It was then transferred to a weak solution of formalin; whereupon its light went out finally, taking several seconds to disappear.

During the day I was unable to find any of the larvæ on the surface of the pool; but the captive specimens had deserted the floating weeds before morning, and were crawling slowly on the bottom of the jar. I did not see them feed, though the water in the jar was full of small animals of different sorts—Copepods, Protozoa, and water-mites. Nor, while I was watching them, did the larvæ ever come to the surface to take in air or to breathe. I can find no special respiratory organs in my specimens: when alive no part of the body was silvery in appearance under water.

Remarks.—The question of luminosity is one even more enigmatical than that of the sounds produced by insects. It is a phenomenon which is manifested right down among the Protozoa, and even in the border-land between the two great kingdoms; it reaches its highest development among some of the *Lampyridæ*. In the Westmann Isles I have seen a whole village accidentally lighted up by the action of putrefactive bacteria in cods' heads hanging to dry on the walls of the gardens; and a dead shark upon the shore was visible on the darkest night from the same cause to the distance of half a mile. *Noctiluca* and other marine animals—cœlenterates, crustaceans, tunicates, &c.—produce even more astonishing luminescent effects. It is not apparent what is the object of this display among these forms; though possibly in the case of the Medusæ it may serve as a lure for prey, as it appears to do among certain deep-sea fishes. Among the insects and Myriapoda the purpose of luminescence is also obscure[1]. It

[1] See Dubois, Bull. Soc. Zool. France, "Les Elatérides lumineux" (1886), &c.

cannot be in all cases a sexual attraction, for it is exhibited by larvæ and even by eggs[1]; neither can its object always be to attract prey: that it is a warning to enemies seems hardly probable, for most small animals, whether aquatic or terrestrial, are attracted rather than repelled by light. In the bacteria and in forms like *Noctiluca* it appears to be an adventitious result of metabolism rather than to bring any practical gain to the organism; among the adults of the *Lampyridæ* it very probably acts as a sexual charm; among the larvæ of the same group its purpose may possibly be to attract prey. In the case of the aquatic form there must be some reason why the larvæ should come to the surface at night and display their light on the top of the water. That purpose can hardly be to warn surface enemies not to eat them, or to scare away aerial aggressors. Much more probably the light attracts some surface or aerial prey. The fact that the light disappears when the water is disturbed also supports this view. It is not to the advantage of the larvæ to attract the attention of any animal big enough to make a commotion in the pool.

In three other species of Lampyrid larvæ, all terrestrial,—two, which were both over an inch in length, being found crawling on the ground among bushes in Patalung, and the other seated on a cocoanut-husk under a house in Kelantan—the light, which was situated in all cases on the ventral surface of the abdomen, was steady, and neither flickered as it did in the winged forms, nor slowly disappeared without apparent cause as in the case of the aquatic larva. A small specimen which I found under the mosque at Aring, mistaking it at first sight for luminous fungus which grew there commonly, continued shining when picked from the ground, but immediately became dark when dropped into formol, and never shone again. Professor Poulton tells me that North-American[2] fire-flies lose control of their lights when placed in a cyanide-bottle, and are no longer able to extinguish them. The same is true of the Malayan winged forms, though occasionally a specimen becomes entirely dark for a few minutes when first introduced into the bottle. The aquatic larva which allowed its light to reappear after it had been in corrosive sublimate for some minutes was probably only just beginning to become affected, for corrosive penetrates hard chitin very slowly. The insect allowed itself, when once affected, to be transferred into a more pungent medium before it finally ceased to shine.

Of all the manifestations of luminescence among animals there is none more curious, or, in the present state of our knowledge, more inexplicable, than the manner in which large numbers of individuals of certain fire-flies are able to display their light with absolute apparent simultaneity and unison and with regular intervals of darkness, under circumstances which make it impossible for all the members of the swarm to see one another. Even the power,

[1] See Dubois, Bull. Soc. Zool. France, xii. 1887, p. 137.

[2] Darwin makes very much the same remark with regard to the Brazilian forms, in his 'Voyage of a Naturalist' (p. 30).

possessed by some peculiar South-American beetles[1], of showing lights of different colours on different parts of the body at the same time is not more wonderful, or more conspicuous, than this. The phenomenon is not common on the east coast of the Malay Peninsula, where the soil is sandy; but it is said to be often manifested both in Siam proper and among the mangrove-swamps of Perak and Selangor in the west. I have only been able to see it on one occasion, and that was on the bank of the river near Kuala Patani, one fine evening at the end of June.

A large tree was covered with many hundreds of fire-flies, the majority of which seemed, judging from the similarity of their lights, to belong to one species, or perhaps to one sex. There were three individuals seated together, however, whose lights were larger and bluer than those of the others. The lights of all the specimens of the more abundant variety flickered in unison with one another; those of the minority, the three individuals, flickered together also, but in a different time. At one instant the tree was all lighted up as if by hundreds of little electric lamps; at the next it was in complete darkness, except for three blue points. Then, again, it was covered with white points, except for a little patch of darkness where the three blue lights had been, and would be again immediately. A similar power of displaying luminosity in unison is said to be exhibited by some marine animals, even after they have been removed from the water; but the questions as to how this unison is effected and what is its exact object are obscure. The power by which it is regulated may be somewhat analogous to that which causes all the individuals composing a flock of birds to wheel at the same instant. As Professor Poulton has pointed out to me, the rhythmical display of light among a crowd of individuals appears much more conspicuous to the eye than the simple flickering of a number of independent points.

Malay Names.—The ordinary Malay term for a fire-fly is *klip-klip*, a name which seems to suggest the rapid flickering of the insect's light, though the word *klip* is used in the sense of to glitter. Our west-coast servants called the luminous beetle larvæ with which we met in Pataluug, "*klip-klip tanah*," land or earth fire-flies. The aquatic species, which they had never seen or heard of before, they christened "*klip-klip ayer*," or water fire-fly. His Excellency Phya Sukum, the Siamese Chief Commissioner for the Ligor Circle, to whose hospitality and administration we owed much, tells me that he has seen, in the south of Ligor and near Singora, a large green worm which sits on trees, and it is so brilliantly luminous at night that it well deserves its Siamese name of Lightning Grub. On one occasion he secured a specimen, and was conveying it to Bangkok; but unfortunately it was killed on the voyage through the carelessness of a servant who closed the box in which it was.

[1] See Haase, Deutsche ent. Zeitschr. 1888, pp. 146–167.

VII. The Use of the Spines of certain Orthoptera.

The Locustid (*Eumegalodon blanchardi*).

Colour and Form.—The whole exposed surface of this well-known and peculiar form is coloured pale brown, speckled, but not in any very marked way, with a darker shade. Its coloration bears a general, and by no means highly specialized, resemblance to a withered leaf.

The most peculiar features of its external form are the enormous stoutness of the head and jaws, and the well-developed thorn-like processes on the thorax.

Habits.—The only specimen secured was captured in a rice-field, then partially flooded, at Belimbing in the Ulu Legeh, on July 22nd. I was crossing the swamp towards a solitary tree of large size that grew on the embankment halfway across. When about ten yards distant from this tree, I noticed what appeared to be a dead leaf falling from one of its lower branches at a height of perhaps eight feet from the ground. Judging from the way it fell that the leaf must have something, perhaps a chrysalis, attached to it, I left the embankment and waded to the place where it had touched the ground, and was surprised to find a fine male specimen of *Eumegalodon* seated motionless on the damp earth. It made no attempt to escape but did its best to defend itself with its really formidable mandibles, a bite from which would have taken a piece right out of the finger.

Remarks.—It is very dangerous to generalize from a single instance of this sort; but the behaviour of the insect was interesting, and may possibly cast some light on the use of the peculiar spines on its back. I am sure, from the rapidity with which it fell and from its appearance while in the air, that the wings were folded as it dropped from the tree; I am also convinced that it dropped and did not leap down. Supposing that its usual habit is to descend thus—and I have no reason to suppose that the behaviour of my specimen was at all peculiar—it is easy to see that its spines, combined with the sturdy build of the anterior part of its body, might assist greatly in breaking its fall, should it strike against anything hard or sharp; for necessarily it would fall head downwards, the head and thorax being heavier than the abdomen. This suggestion does not interfere with the view that these structures may also be of use in defending the insect against its enemies, whatever they may be, should it be attacked from behind; in which case its jaws could not assist it; very possibly it may drop from the tree to escape assailants. Professor Meldola has suggested the same use for the hairs and spines on caterpillars.

VIII. The peculiar Prolongation of the Head in certain Fulgoridæ, and its use.

Hotinus, Pyrops, &c.

The curious anterior prolongation of the head in many genera of the Fulgoridæ has long puzzled entomologists, and some have

been found bold enough to suggest that in life it is luminous[1]; being led to this suggestion, I suppose, by the lantern-like outline of the "nose" in the more highly specialized members of the family, and perhaps by the fact that some of the species at any rate are nocturnal or crepuscular, and rest by day on the trunks of trees in a very open manner. At Biserat in Jalor I was fortunate enough to observe the real use of this peculiar structural modification.

On the morning of May 30th, I noticed a specimen of *Hotinus spinolæ* seated on the trunk of a Durian tree in the village and incautiously attempted to catch it in my hand. The insect remained almost still, merely drawing in its legs towards its body and pressing the claws firmly against the bark, until I had almost touched it. Then, it lowered its head with very great rapidity, flew up into the air without spreading its wings, and alighted on the roof of a house about six feet behind the tree and considerably higher than the position on the trunk whence it had started. When it was at rest its dorsal surface had been directed towards the roof and its head had pointed upwards; but it started off at a tangent from its original station, and landed with its head, speaking roughly, at right angles to an imaginary line drawn through the main axis of the body as it had been on the tree. The insect remained on the roof without moving while I went to get a butterfly-net, in which it was easily captured by a man who swarmed up one of the house-posts.

At the time I did not notice anything peculiar in the way in which this Fulgorid jumped, for there are many large species of the same family (e. g. *Aphæna atomaria*) which, without being provided with long noses, can leap for a considerable distance by means of their legs only; but, as I was examining my specimen after it had died in a cyanide-bottle, I was struck by an indentation or crease that ran across the central region of the nose, at right angles to its main axis. Then I discovered that the chitin was flexible at this point, and at this point only; and that if the tip of the nose and the dorsal surface of the abdomen were pressed together between the finger and thumb and then suddenly released, the insect would not fall straight to the ground, but would be propelled for some distance through the air before doing so; just as would be the case if a piece of whalebone were treated in like manner. Now supposing that the whalebone (representing the nose of the insect) was fixed rigidly to a small rigid object (the head), which in its turn was fastened by a flexible juncture to a larger rigid object (the thorax and abdomen); supposing that the larger object was then laid so that it rested for all its length along a smooth vertical support with the whalebone pointing in front of it, that the free extremity of the whalebone was bent downwards by some force, and that the whole structure was simultaneously shoved away from the support (as the body of

[1] For a coloured picture of a *luminous* Fulgorid, see Donovan's 'Natural History of the Insects of China,' p. 27; also for much evidence as to its luminosity.

the insect might be by its legs), it is obvious that the whole structure would fly off into the air at a tangent; only supposing that the pressure was slightly oblique at any point. I have no doubt that this is substantially what occurs in the case of *Hotinus*; but in the living insect the action is far too rapid for the eye to discriminate its details, and dead specimens cannot be made to leap in this way, because it is impossible to force the legs to perform their part of the action. In two specimens of *Hotinus*, which I observed on tree-trunks at Aring, the wings were spread after the insects had leapt into the air, but not immediately they left their perch. Both of them distinctly bent down their heads before they jumped.

The nose is perfectly hollow, and does not appear to contain any muscle. It differs, of course, from the whalebone in respect of its hollowness, and also in that it is only flexible at one point. In specimens preserved in spirit it is largely filled with liquid, but contains a bubble of air, which naturally rises to the tip when the apparatus is in its resting position, and runs towards its base when the head is lowered.

When I had made the discovery in my first specimen of *Hotinus*, I examined some Fulgorid larvæ, almost certainly those of *Pyrops nobilis*, which had been brought to me by a native at Ban Sai Kau in Nawnchik, and which I had preserved in spirit. The nose was well developed in these, although the abdomen was still small and unexpanded and the wings as yet mere stumps. I found that the joint was present in these specimens also, and still retained a certain amount of springiness, though they had been dead for a month.

Since coming home, I have been enabled, by the kindness of Professor Poulton, to examine dried specimens of twenty-six species of long-nosed Fulgoridæ, belonging to nine genera. In individuals of sixteen of these species I am able to distinguish a crease running across the nose in exactly the same position as it does in my specimen of *Hotinus*. All of the remaining ten species in the Hope Collection, of which species *Pyrops nobilis* is one, have either comparatively short, spiny, or otherwise peculiar noses. I have no doubt that the joint would be found in them also, were fresh specimens examined; even in my larvæ, in which it is still flexible, there is no external sign of its existence except a slight translucency of the integument. The members of the bulbous-nosed American genus *Fulgora* probably use their heads in the same manner as the less highly modified Oriental forms. There is a deep hollow across the noses of the former which seems to correspond to the crease in that of *Hotinus*; and I have satisfied myself at any rate that a certain very limited flexibility exists at this point even in dried specimens. What is wanted is a series of instantaneous photographs from life.

Malay Name.—At Biserat *Hotinus spinolæ* goes by the name of "*Raja Legeh*," but this is probably a corruption of some more direct appellation.

[32]

A large proportion of the insects mentioned in this paper have been identified by comparison with specimens preserved at Oxford in the Hope Department of the University Museum, to the officials of which I offer my thanks for the ready help which they have given me. I cannot conclude without expressing my personal gratitude to the Siamese Government for the kindness and generosity with which it treated us throughout: to the officials at Bangkok and Singora who arranged for our reception in lower Siam: to the Malay Rajas through whose territory we passed, without whose aid the Siamese Malay States are practically a closed country to Europeans: and to Luang Phrom, Commissioner of Patani, to Kun Rhat Wan Hussein, and to the other gentlemen who accompanied us as agents of the Siamese Government; at whose hands I received much personal kindness, and whose assistance and advice made it possible to travel in such a country with physical comfort and with some degree of celerity.

OBSERVATIONS ON SOME MIMETIC INSECTS AND SPIDERS FROM BORNEO AND SINGAPORE.

BY R. SHELFORD, M.A., C.M.Z.S., Curator of the Sarawak Museum. With APPENDICES containing Descriptions of new Species by R. SHELFORD, Dr. KARL JORDAN, C. J. GAHAN, the Rev. H. S. GORHAM, and Dr. A. SENNA.

[*From the* PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON, November 4, 1902.]

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(Plates XIX.–XXIII.[1])

The theory of mimicry having originated and having been further elaborated chiefly from a study of South American insects, it is but natural that these should figure largely in all works relating to the subject. This paper, a brief abstract of which, arranged by Professor Poulton, appeared in the British Association Reports, 1900, p. 795, is an attempt to bring into greater notice the richness of the Malayan sub-region in similar mimetic species—nearly all the examples here described and discussed having been captured within the last four years in a circumscribed area of 10 mile radius, with Kuching, the capital of Sarawak, as its centre. A recent collecting-trip of three weeks' duration to Mt. Penrissen (about 50 miles inland) was productive of several new examples; and I feel convinced that a similar reward awaits the collector on other mountains of the island and on those of Sumatra, Celebes, and other numerous islands of the great Archipelago, many of which are still virgin ground to the entomologist.

In order to summarize as much as possible our knowledge of the mimetic insects of Borneo, I have drawn up tables of the mimetic Longicorn Beetles and of the Lepidoptera; the latter is a modification of a somewhat similar list given by Haase in his 'Researches on Mimicry' (English translation), Stuttgart, 1896, but I have found it necessary to question certain conclusions and to make a few additions.

[1] For explanation of the Plates, see page 281.

It is frequently possible to pair a mimicking species with a definite specific model, but perhaps more frequently the mimic (either a Batesian or a Müllerian mimic) in its general appearance resembles a whole group of known distasteful insects; or, in other words, the general appearance of the mimic is typical of a distasteful group, rather than exactly similar to one definite species; and in these tables of mimetic Longicorns and their models I have by no means included all, but merely typical models.

The diagrammatic tables of convergent groups of pseudaposematic and synaposematic insects at the end of the paper include, however, all the known distasteful insects which serve as models in the respective groups.

In the Appendices are described a new species of Butterfly, a new Moth, two new genera and several species of Longicorn Beetles, two new Clerids, and two new Brenthids. I owe the description of all except the first-mentioned species to the kindness of Dr. Karl Jordan, Mr. C. J. Gahan, the Rev. H. S. Gorham, and Dr. A. Senna.

Professor E. B. Poulton, F.R.S., has added some interesting and suggestive remarks on my observations: these are scattered throughout the paper, but in all cases his initials are affixed.

My task, in the absence of a large library and of named collections for comparison and reference, has not been easy, but I have received the most valuable and generous aid from Professor Poulton, whom I feel that I can never sufficiently thank. It is not too much to say that had it not been for his help this paper could not have been written. Most of the specimens here described and figured are now deposited in the Hope Museum, Oxford, where they can be seen by all students of the subject. I am much indebted to Mr. H. N. Ridley, Director of the Botanic Gardens, Singapore, for directing my attention to some interesting cases of mimicry observed by him and for some valuable notes thereon. Mr. Gilbert J. Arrow, Monsieur Jules Bourgeois, Mr. Malcolm Burr, Sir G. Hampson, Dr. F. A. Dixey, Dr. R. Gestro, the Rev. O. Pickard-Cambridge, F.R.S., Mr. R. McLachlan, F.R.S., Mr. W. L. Distant, Mr. C. J. Gahan, Dr. Senna, Mr. M. Jacoby, Col. Bingham, Mr. E. E. Austen, Mr. C. O. Waterhouse, Dr. Brunner von Wattenwyl, and Col. Yerbury have rendered much kind assistance in identifying many of the species noted in this paper, and to these gentlemen I tender my grateful thanks.

I. ORTHOPTERA AS MIMICS.

i. **Mimic.** Larva of *Hymenopus bicornis* (Stoll).
Plate XIX. figs. 17 & 19. × 2.

Model. Larva of *Eulyes amœna* (Fab.).
Plate XIX. figs. 16 & 18. × 2.

The newly-hatched larvæ of *Hymenopus bicornis*, one of the

Harpagid Mantidæ, mimic the young larvæ of the Reduviid bug, *Eulyes amœna*, not only in coloration, but also in the peculiar habit of walking about with the abdomen curled over the back (compare figs. 16 & 17). When the young Mantides first emerge from the ootheca they are of a brilliant red colour, the head, basal joint of the antennæ, apices of the femora, and the tibiæ alone being jet-black. A similar arrangement of colours is exhibited by the young of *E. amœna*: in these the head, apices of the femora, bases of the tibiæ, the wing-rudiments, and some spots on the dorsal surface of the abdomen are black, whilst all the rest is vermilion (compare figs. 18 & 19). The newly-hatched larvæ of the bug are very much smaller than the corresponding stage of the Mantis, but after the second moult the size of the former is almost the same as that of their mimics when newly-hatched. The brilliant coloration of the bug is essentially a warning signal, being correlated with an objectionable smell and presumably a still more objectionable taste, judging from the expressions of disgust manifested by two tame monkeys (*Macacus cynomolgus*) after tasting the specimens I offered them. The young *Hymenopus* they had eaten with the utmost sangfroid a few days before, from which one may justly conclude that in this case the coloration is deceptively warning or pseudaposematic (truly mimetic). It is unfortunate that I was unable to rear, or even to keep alive for a few days longer, the young Mantides; but they are notoriously difficult insects to rear, and all my specimens died before I was able to obtain the young of *Eulyes amœna*. The pupa and adult of this species of Mantis are floral simulators: the former resembles a pink Melastoma; the latter, which is cream-coloured varied with brown, resembles the flower of an orchid of fairly common occurrence; and I have also seen a young larva which bore a striking resemblance to a small pink flower of an order not known to me. I have had this insect in various stages of its life-history frequently under observation, and can confirm in almost every detail Mr. Annandale's recently published account of the habits of the pupa (*cf.* P. Z. S. 1900, pp. 839 *et seq.*). That the insect should mimic in the youngest stage of its life-history a distasteful and conspicuously-coloured bug is a fact of some interest.

[The late Mr. L. de Nicéville states, in a letter to Prof. Poulton, that he had reared some species of Mantidæ; one species when newly hatched was remarkably like a small black ant, the deceptive resemblance being so close that a careful scrutiny was necessary to determine the exact nature of the insect. Mr. de Nicéville also remarks:—" A Mantis of fair size does not often move but waits for its prey to come to it, but these young ones ran about incessantly looking for their prey, just like the ants they mimicked."]

ii. **Mimic.** *Condylodera tricondyloides* (Westw.).
Plate XIX. figs. 2, 4, & 6.

Models. *Cicindelidæ.* Plate XIX. figs. 1, 3, & 5.

I was fortunate enough to discover in Sarawak the remarkable Locustid, *Condylodera tricondyloides*, originally described in 1837 by Westwood from Java (Trans. Linn. Soc. vol. xviii. p. 409); the type specimen was at first placed by Westwood in his collection of Cicindelidæ, "regarding it as an immature *Colliurus* or *Tricondyla*" (l. c. p. 419). Another Javan specimen was actually given the MS. name of *Tricondyla rufipes* by Duponchel, so close is the resemblance of this highly deceptive Locustid to a Tiger-beetle. Both these historical specimens are now in the Hope Collection at Oxford, and have been compared with the Sarawak specimens by Mr. Malcolm Burr.

My first specimen, which is somewhat larger than the type, was found in jungle in the neighbourhood of Kuching, running about on the ground amongst dead leaves and other vegetable débris, an environment much frequented by a large Tiger-beetle, *Tricondyla cyanea* (Dej.) var. *wallacei* (Thoms.), with which this Locustid is almost identical in appearance (compare Plate XIX. figs. 1 & 2). The shape, size, coloration, and even the gait of the mimic so closely resembled the corresponding traits of its model, that I did not suspect the importance of my find till a careful examination of the collecting-box had been made some hours after the time of capture. The colour of the head, thorax, and abdomen of the *Condylodera* is a dark shining blue, the femora of all the legs are red, the hind femora (which are only slightly swollen) having in addition a proximal black band. The head with its large prominent eyes, somewhat flattened face, and conspicuous jaws, is very Cicindelid in appearance. The antennæ are of extreme tenuity and are about $2\frac{1}{2}$ to 3 times as long as the body. The densely-punctured prothorax is globosely swollen about its middle, the swelling being marked off from the elevated anterior border and posterior portion by broad constrictions. The tegminal and wing rudiments lie very closely adpressed to the body and do not disturb the even contour of the dorsal aspect. The abdomen, though hardly so bottle-shaped as are the elytra and abdomen of the model, is not widely different in appearance, and the intersegmental membranes are quite concealed except on the ventral surface, where the scuta are small, as is usual in this group of insects.

The model is so common and so well known a species that it is unnecessary to describe its general appearance; the above brief description of its mimic will suffice to show in how many superficial points the two insects agree, and superficiality of resemblance is the key-note of mimicry.

Another specimen of this mimetic Locustid of the same size was obtained a few months later in the same locality; and both these

are pronounced to be fully adult by that well-known authority on the Orthoptera, Mr. Malcolm Burr.

Bearing in mind the errors made by Westwood and Duponchel with regard to this insect, I made a careful search through the Sarawak Museum collection of Cicindelidæ, and was rewarded by finding yet another example of this remarkable mimic placed amongst specimens of *Tricondyla gibba* (Chaud.), which it most closely resembles as regards size, coloration, &c. The specimen was smaller than those described above and is evidently a younger stage, but it differs in hardly any other way; and *T. gibba*, the model, also differs from *T. cyanea* var. *wallacei* principally in size (compare Plate XIX. figs. 3 & 4).

A fourth specimen, of a very early stage, was taken in Kuching on the flowers of a flowering tree, frequented also by numerous insects of all orders, amongst others being the Cicindelid, *Collyris sarawakensis* (Thoms.), which serves as a model to the young *Condylodera* (Plate XIX. figs. 5 & 6). At this stage, the insect is entirely dark blue, except the legs which are dark brown, and the greater part of the long antennæ which are ochreous, the four basal joints only being blue. The prothorax shows no trace of the conspicuous puncturation of the adult, nor is it swollen as in the later stages, but more or less cylindrical like that of its model; the wing-rudiments are not yet visible, and the auditory organ on the fore-tibiæ can only be distinguished with difficulty. The model is somewhat larger, of a uniform dark blue with the legs dark brown. It is somewhat curious that the young *Condylodera* does not mimic *Collyris emarginata* (Macl.), a smaller species with red legs, especially since in the later stages it is red-legged species of Cicindelidæ that are mimicked; *C. emarginata* is, however, of a much more brilliant blue than any other Bornean members of the genus, or than the species of *Tricondyla*. This case of mimicry appears to me to be of exceptional interest and without a parallel. I have shown that *Hymenopus bicornis*, a floral simulator throughout the greater part of its life, mimics in its young stages the larvæ of a bug; but I know of no ametabolous insect, except *Condylodera tricondyloides*, which mimics different species of one family during the successive periods of its growth.

iii. **Mimic.** *Gryllacris* n. sp. vicinissima *nigratæ* (Br.). Plate XIX. fig. 8.

Model. *Pheropsophus agnatus* (Chaud.). Plate XIX. fig. 7.

The model in this instance is one of the "Bombardier Beetles," and discharges, when seized or irritated, a jet of formic acid vapour quite powerful enough to scorch the skin of the finger severely and to leave an indelible brown stain on paper or cloth. The insect is quite conspicuous, being black with orange spots on the dorsal surface of the thorax and tegmina; the legs and antennæ are entirely orange. The Locustid is somewhat larger,

and though the markings do not correspond accurately with those of the model, a general resemblance is produced. The head is orange, the prothorax is black with large orange blotches, the tegmina are black with an orange spot at the base of each, corresponding to a similar spot at the base of each elytron of the beetle, and with an orange fascia about the middle, corresponding to a broad orange spot in a similar position on each elytron of the beetle. The legs are banded with orange and black (compare Plate XIX. figs. 7 & 8). The mimic is met with amongst herbage in jungle, and all the examples of the somewhat common "Bombardier" that I have met with were taken in the same environment. The powerful jaws of the larger Gryllacrides furnish possibly an efficient protection against the attacks of vertebrate enemies, such as small birds, lizards, and frogs, but in so small a species as this the resemblance to a beetle capable of discharging a scorching jet of formic acid vapour must be a far more efficient means of protection.

iv. **Mimic.** Nov. gen., nov. sp. vicinissima *Gammarotettigi.* Plate XXIII. fig. 34.

Model. *Coccinellidæ.* Plate XXIII. fig. 30.

In February 1901 the Museum collectors brought in a small Locustid of a brilliant vermilion colour spotted with black. When the insect was resting the head was bent downwards and almost concealed by the large prothoracic shield, the abdomen was strongly curved downwards and the legs were drawn close up to the body, the long hind tibiæ being bent up under their femora: in this attitude the resemblance of the insect to a black-spotted red "ladybird" of a convex shape, e. g. *Caria dilatata* (Fab.), was most striking (compare Plate XXIII. figs. 30 & 34). The eyes are intense black; the large prothoracic shield has three black spots, one central, the others lateral; the segments of the abdomen bear each a small dorsal black spot, decreasing in size posteriorly; the fore- and mid-femora bear outwardly one conspicuous spot, whilst the hind-femora have two such spots.

When touched, this little Locustid did not leap away, as might have been expected, but kept perfectly still, and if further irritated it simply rolled off the surface on which it was resting and assumed a death-like attitude on the ground below, thus simulating very perfectly the habits of a Coccinellid.

I have to thank the distinguished orthopterist Brunner v. Wattenwyl for reporting on this Locustid and the Gryllacris.

II. NEUROPTERA AS MIMICS.

i. **Mimic.** *Mantispa simulatrix* (McLachl.). Plate XIX. fig. 23.

Model. *Bracon* sp. Plate XIX. fig. 22.

This case offers an instance of the distastefulness of the Hymenoptera Parasitica, a group mimicked also by insects

belonging to the most diverse orders, such as Hemiptera, Diptera, Lepidoptera, and Coleoptera.

The model is one of those reddish-ochraceous Braconids, of which there are many representatives in Borneo, all being more or less common. This particular species, with a conspicuous black stigma on the fore wing, is eminently a mountain form, as the numerous specimens in the Sarawak Museum bear witness. Mt. Matang at any elevation above 1500 feet is its favourite haunt, but I have never taken it below that altitude. The mimic, which was recently described[1] by Mr. McLachlan, was captured in the month of August also on Mt. Matang, at an altitude of 2500–2800 feet. It, too, is reddish-ochraceous, whilst each wing bears a black stigma, those on the fore-wings being slightly more conspicuous than those on the hind-wings; the sides and ventral surface of the abdomen are pure white (in the fresh condition), so that when the insect is seen in profile its somewhat bulky body appears to be reduced approximately to the size of the body of its model; as, further, the model also has the ventral surface of the abdomen coloured white, the resemblance between the two insects is still greater (compare Plate XIX. figs. 22 & 23). This method of producing a thin-bodied or wasp-waisted effect by white patches is by no means uncommon amongst insects; I shall be able to give further examples of it in this paper (*vide infra*, pp. 238, 241), and at present need only refer to the well-known Soudanese Locustid *Myrmecophana fallax* (Br.) mimicking an ant, and to the Moth *Pseudosphex hyalina* which mimics a Sphex.

ii. **Mimic.** *Mantispa* sp. Plate XIX. fig. 27.
Model. *Polistes sagittarius* (Sauss.). Plate XIX. fig. 26.

The Wasp, *P. sagittarius*, is an extremely common species and is rendered highly conspicuous by reason of a red band on the second abdominal segment; the rest of the body is black, varied on the head and thorax with a rich red-brown; the wings are fuscous, becoming flavo-hyaline outwardly. The mimic is black with the second and third abdominal segments red, the width of these two segments closely corresponding with the large second abdominal segment of the wasp; the wings are hyaline, but largely shaded with fuscous at the base and along the costal margins and flavo-hyaline at the apex (compare figs. 26 & 27). A closely allied species from Assam is in the Hope Collection at Oxford, with the MS. name of *M. nodosa* (Westw.). The specimen belonged to the Cantor Collection.

iii. **Mimic.** *Mantispa* sp. Plate XIX. fig. 25.
Model. *Polistes* sp. near *diabolicus* (Sauss.). Plate XIX. fig. 24.

The general colour of the Wasp is reddish-brown, the abdomen is covered with a fine silky pubescence golden in colour; this

[1] Ent. Month. Mag. (ser. 2) vol. xi. 1900, pp. 127–128.

pubescence is denser at the apices of the segments, forming here narrow yellow bands; the wings are flavo-hyaline, sometimes with a brown stigma.

The mimic is of a reddish hue, the abdomen is a little paler, corresponding to the red-brown seen through the golden pubescence of the wasp's abdomen; the apex of each segment is narrowly banded with yellow. The wings are broadly hyaline along the costal margins and there is a brown stigma. A closely allied species from Celebes is unnamed in the British Museum.

Both this and the preceding *Mantispa* were referred to Mr. R. McLachlan, who pronounced them to be undescribed species.

iv. **Mimic.** *Mantispa* ? *cora* (Newm.).
Model. *Mesostenus* sp.

A small black-and-yellow banded *Mantispa* was caught on the hill, Bukit Timah, at Singapore amongst short undergrowth, and at the same time I took also several specimens of a common Ichneumon-fly very similarly coloured. The *Mantispa* was extremely active on the wing and at first sight almost indistinguishable from its model. I append some colour notes on the two insects:—

Mantispa.—Ground-colour of head, thorax, and abdomen black, the following bands bright yellow—two vertical on the face, one transverse on the vertex, an anterior transverse and three longitudinal on the prothorax, one transverse on both meso- and metathorax, which are ventrally blotched with yellow; abdomen alternately banded black and yellow. Anterior legs yellow blotched with black, mid- and posterior femora broadly banded black and yellow. Bases of wings yellow and a distinct black stigma on the fore wings.

Mesostenus sp.—Head yellow; prothorax black bordered with yellow and with two central yellow stripes; mesothorax yellow with a central black spot; metathorax posteriorly yellow; abdomen banded alternately black and yellow. Legs yellow blotched with black. Anterior wings with a conspicuous stigma.

I subsequently found the same species of *Mantispa* or a close ally in Borneo, frequenting the blossoms of a Hibiscus; the plant was also visited in considerable numbers by a small yellow-and-black *Icaria* and by a similarly coloured ichneumon-fly; a somewhat careful scrutiny was needed to distinguish these insects one from the other.

III. COLEOPTERA AS MIMICS.

I wish especially to acknowledge the kind assistance received from Mr. C. J. Gahan in working out this section of my paper.

Most of my examples are taken from the Longicornia, and I have drawn up tables of the mimetic species of the group occurring in Borneo. I have made these as complete as possible, but there are a few described species which I have not seen and which have

never been figured. Such species have been included in the appended tables, when their descriptions have shown that they do not differ in characters of mimetic importance from the closely allied species with which I am acquainted; in every case these are marked with an asterisk. I have not included a large concourse of species belonging to the subfamilies *Mesosinæ* and *Apomecyninæ*, which present in their general facies a marked resemblance to the Rhynchophora, for, although the tyro in entomology might readily mistake many of these longicorns for Rhynchophorous species, I have, nevertheless, found it quite impossible to pair any one given species with a definite model. The resemblance is in fact, as is so frequently the case, general and indefinite, not special as, for example, in the species of the subfamilies *Astatheinæ* and *Saperdinæ*, which mimic for the most part definite species of the Phytophaga. It will therefore suffice if I simply enumerate here those genera of the *Mesosinæ* and *Apomecyninæ* which present most markedly Rhynchophorous features:—

Subfam. *Mesosinæ*:—*Anancylus*, *Planodes*, *Ereis*, *Cacia*, *Mnemea*, *Sorbia*.

All these Coleoptera, more especially *Ereis anthriboides* (Pasc.), have a general resemblance to Anthribidæ.

Subfam. *Apomecyninæ*:—*Cenodocus*, *Synelasma*, *Etaxalus*, *Phesates*, *Praonetha*, *Sybra*, *Ropica*.

These bear a general resemblance to Curculionidæ.

Notes on Table I.—*Longicorns mimicking Hymenoptera.*

The subfamily *Phytæciinæ* furnishes ten and probably more species belonging to three genera which mimic the Braconidæ. The models can be divided into two sections:—(1) species with dark red head and thorax and black abdomen and wings (genus *Myosoma*); (2) reddish-ochreous species (genus *Iphiaulax*), one of which has already been shown to be mimicked by *Mantispa simulatrix*. *Scytasis nitida* (Pasc.) and four species of *Oberea* are coloured in identically the same way as their models, the red-and-black Braconids. Furthermore, *S. nitida* and three out of the four species of *Oberea* (the exception being *O. rubetra* (Pasc.)) are marked with a large white patch of pubescence on the sides of the first and second abdominal segments, which patches, when the beetle is seen in profile, give an impression of a wasp-like waist, from the posterior end of which the abdomen appears gradually to swell in size. This effect is shown in Plate XIX. figs. 13, 14, & 15, representing respectively *Oberea strigosa* (Pasc.) var., *O. brevicollis* (Pasc.), and *Oberea* probably n. sp. near *strigosa* (Pasc.). The thin waist of the model is not seen from above when the insect is at rest, being hidden by the laid-back wings, and consequently this obviates the necessity of dorsal white patches on the mimic as in the African Locustid *Myrmecophana fallax*, whose model is a wingless ant with an abdominal peduncle plainly

TABLE I.—*Longicorns mimicking Hymenoptera.*

		Mimics.	Models.
Fam. LAMIIDÆ.	Subfam. *Phytæciinæ.*	1. *Scytasis nitida* * (Pasc.).	Red-and-black Braconidæ of the genus *Myosoma.*
		2. *Oberea brevicollis* (Pasc.) (probably = *curialis* (Pasc.).	
		3. „ n. sp. between *macilenta* (Pasc.) and *strigosa* (Pasc.).	
		4. „ *strigosa* (Pasc.) var.	
		5. „ *rubetra* (Pasc.).	
		6. „ sp. near *rubetra* (Pasc.) and probably a form of it.	Reddish-ochreous Braconidæ of the genus *Iphiaulax.*
		7. „ *insoluta* (Pasc.).	
		8. „ *consentanea* (Pasc.).	
		9. „ probably ♂ *consentanea.*	
		10. „ n. sp.	
		11. *Nupserha*, n. sp.	
		12. *Glenea iresine* (Pasc.)	*Hylotoma pruinosa* (Cam.).
Fam. CERAMBYCIDÆ.	Subfam. *Callichrominæ.*	13. *Nothopeus intermedius* (Gahan)	*Salius aurosericeus* (Guér.).
		14. „ *fasciatipennis* (Waterh.)	*Mygnimia aviculus* (Sauss.)
		15. „ sp. near *hemipterus* (Fab.)	„ *anthracinus* (Sm.).
	Subfam. *Necydalinæ.*	16. *Psenida brevipennis* (Gahan)	*Myosoma* sp.
		17. *Epania singaporensis* (Thoms.)	*Melipona vidua.*
		18. „ *sarawakensis* (Thoms.) *	Ants.
	Subfam. *Tillomorphinæ.*	19. *Halme cleriformis* (Pasc.)	„
		20. *Clytellus westwoodi* (Pasc.)	„

visible both in a dorsal and a profile view. A species of *Oberea* near *rubetra* (6), and probably a form of it, is really intermediate in character between these two sets of mimics, the elytra being brown anteriorly (basally) and black posteriorly. The remaining species of *Oberea* mentioned in the table mimic the reddish-ochraceous Braconids. *O. insoluta* and the species of *Nupserha* have a pale golden pubescence on the basal abdominal segments, and *O.* sp. (10) has a similarly situated greyish pubescence: in every case this coloration is not so effective as the white patches of *O. brevicollis*, &c.; but these unicolorous *Obereas* are so much more active on the wing, so much more Hymenoptera-like in their actions when resting on a leaf or twig, that when they are alive one is much more apt to mistake them for their models than their bicolorous congeners. In other words, these unicolorous *Obereas* compensate for the imperfection (from a mimetic point of view) of their coloration by their close approximation to the actions of their models. *O. consentanea* (8 & 9), *O.* sp. near *rubetra* (6), and *O.* n. sp. (10) have the elytra clothed with a delicate silky-grey pubescence, especially in the posterior two-thirds, the appearance varying according to the position in which the insect is held; and these species mimic Braconids with the outer third of the wings pale fuscous, the varying reflections of the elytra giving a similar impression to that produced by the semitransparent fuscous parts of the model's wings.

Glenea iresine (Pasc.) is a small blue species; the middle third of the elytra is brown, shading anteriorly into blue, posteriorly into greyish white; the model is a small blue *Hylotoma*, and when the wings are laid back the resemblance between the two species is striking; the blue anterior third of the beetle's elytra corresponds to the posterior part of the *Hylotoma's* thorax, the brown portion to the abdomen with the superposed wings, the greyish posterior third to the tips of the wings of the model, which project beyond the end of the abdomen.

Turning to the family Cerambycidæ, we find that the subfamilies *Callichrominæ* and *Necydalinæ* present in the reduction of the elytra a marked Hymenopterous appearance. *Nothopeus fasciatipennis* (C. O. Waterh.) has already been figured and described (Trans. Ent. Soc. 1885, p. 369, pl. x.). *Nothopeus* sp. near *hemipterus* (Fab.) is a large black species with entirely fuscous wings, and is an admirable mimic of a formidable wasp, *Mygnimia anthracinus* (Sm.), which occurs commonly on Mt. Matang. The buzzing flight and other movements of these two *Nothopei* are remarkably wasp-like and so completely deceived the Museum collectors that they employed the greatest precautions in transferring the specimens from the net to the killing-bottle.

A magnificent new species, described by Mr. Gahan in Appendix II. as *Nothopeus intermedius* (Plate XIX. fig. 21), was captured near the summit of Mt. Penrissen together with several of its models, *Salius aurosericeus* (Guér.) (Plate XIX. fig. 20).

The general colour of the beetle is reddish ochreous, the prothorax is clothed with a fine golden pubescence; the prominent black eyes, the somewhat flattened antennæ, and long hind legs closely correspond with the same organs of the *Salius*; further, the elytra, though not shortened, are much reduced in width, rapidly narrowing from a breadth of 3·5 mm. at the base to 1 mm. at the apex, so that the clear golden wings are very imperfectly hidden and add not a little to the general wasp-like appearance. When seized, this beetle curved down its abdomen in the most characteristic wasp-like manner, and it was only with the greatest reluctance and most careful precautions that my Dyak collectors, to whom I pointed out the insect, captured it. As in the *Obereas*, no representatation has here been made in dorsal view of the wasp-waist of the model, and for the same reason, namely, that this is hidden, when the *Salius* settles, by its wings, and it is only at such periods of rest that the full effect of the deceptive resemblance can be appreciated; that part, however, of the first abdominal segment of the *Nothopeus* which is visible from the side and below is clothed with a golden-grey pubescence, which produces the same effect as in the *Obereas*.

It is possible that this species of *Nothopeus* is itself distasteful like the mimicked genera *Chloridolum* and *Leontium* (see later), but I could distinguish no pungent odour like that emitted by those genera, and I am inclined to think that its mimetic resemblance is its sole defence.

I have lately become acquainted with a mimetic species belonging to the subfamily *Necydalinæ* (Plate XIX. fig. 12, no. 16 in Table I.), described in Appendix II. as *Psebena brevipennis*, and I therefore add some details of its habits and of the mode in which the mimetic resemblance is attained. The species in question mimics with a remarkable degree of accuracy one of the common red-and-black Braconidæ: these Hymenoptera, as already shown, serve as models to a considerable number of species of *Oberea*, but in none of these latter is a Hymenopterous appearance so admirably borne as in this, a member of a subfamily for the most part characterized by a reduction of the elytra. The head and prothorax are of an Indian red, the wings are purplish-black, the two anterior pairs of legs are testaceous, the long slender posterior pair black with the bases of the femora white; the body is so slender that the necessity of producing a wasp-waisted effect by means of lateral white patches, as in some of the above-noted *Obereas*, can be dispensed with.

Most of the life of this beetle, as in all Longicorns with reduced elytra, is spent on the wing, when it is simply indistinguishable from its model; when it comes to rest the resemblance is still remarkably exact, and its quick restless movements and habit of flickering the antennæ in all directions are very Bracon-like. No specimen at all resembling this remarkable species has hitherto existed in the British Museum.

Of the *Necydalinæ*, one species *Epania singaporensis* (Plate

TABLE II.—*Longicorns mimicking other Coleoptera.*

		Mimics.	Models.	
LAMIIDÆ.	Subfam. *Mesosinæ.*	1. *Elelea concinna* (Pasc.)	*Arrhenodes* sp.	Fam. BRENTHIDÆ.
		2. *Zelota spathomelina* (Gah.)	*Spathomeles* sp. near *turritus* (Gerst.).	Fam. ENDOMYCHIDÆ.
	Subfam. *Dorcadioninæ.*	3. *Trachystola granulata* (Pasc.)	*Sipalus granulatus* (Fab.).	Fam. CURCULIONIDÆ.
	Subfam. *Hippopsinæ.*	4. *Alibora* sp.	*Baryrhynchus dehiscens* (Sch.).	Fam. BRENTHIDÆ.
		5. *Ægoprepis insignis* (Pasc.)	*Diurus sylvanus* (Senna).	
		6. *Ectatosia moorei* (Pasc.)	„ *shelfordi* (Senna).	
		7. *Dymascus porosus* (Pasc.)	„ *forcipatus* (Westw.).	
	Subfam. *Agniinæ.*	8. *Stegenus dactylon* (Pasc.)	„ *sylvanus* (Senna).	
	Subfam. *Saperdinæ.*	9. *Entelopes glauca* (Guér.)	Coccinellid, e.g., *Caria dilatata* (Fab.).	Fam. COCCINELLIDÆ.
		10. „ n. sp. near *wallacei* (Pasc.)	*Metrioidea apicalis* (Jac.) var.	Fam. GALERUCIDÆ.
		11. „ *ioptera* (Pasc.) *	*Caritheca* sp. near *mouhoti*. Perhaps variety only.	
		12. „ *amœna* (Pasc.)	*Aulacophora boisduvali* (Baly).	
		13. *Serixia aurulenta* (Pasc.)	*Ænidia* sp.	
		14. „ *prolata* (Pasc.)	*Ænidia* sp.	
		15. *Xyaste invida* (Pasc.)	*Melampyrus acutangulus* (Bourg.).	Fam. LYCIDÆ.
		16. „ *torrida* (Pasc.)	*Ditoneces* sp. near *fuscicornis* (Gorh.).	
		17. „ *fumosa* (Pasc.)	Same model as 15.	

LAMIIDÆ.	Subfam. *Astatheinæ.*	18. *Astathes unicolor* (Pasc.)	*Antipha* sp.	Fam. GALERUCIDÆ.
		19. „ *posticalis* (Thoms.)	„ probably *nigra* (Ahl.) var.	
		20. „ *flaviventris* (Pasc.)	„ *abdominalis* (Jac.).	
		21. „ *splendida* (Fab.)	*Caritheca mouhoti* (Baly).	
		22. „ *caloptera* (Pasc.)	*Haplosonyx albicornis* (Wied).	
		23. *Tropimetopa simulator* (Pasc.)	*Metrioidia apicalis* (Jac.).	
		24. *Ochrocesis evanida* (Pasc.)	*Hoplasoma unicolor* (Ill.) var.	
		25. *Chreonoma*, n. sp.	*Ænidia* sp. near *læta* (Baly).	
		26. „ *tabida* (Pasc.)	*Aulacophora luteicornis* (Fab.).	
	Subfam. *Phytæciinæ.*	27. *Daphisia pulchella* (Pasc.)	*Callimerus bellus* (Gorh.).	Fam. CLERIDÆ.
			„ *catenatus* (Gorh.).	
CERAMBYCIDÆ.	Subfam. *Lepturinæ.*	28. *Ephies dilaticornis* (Pasc.)	*Metriorrhynchus kirschi* (C. Waterh.).	Fam. LYCIDÆ.
	Subfam. *Pyrestinæ.*	29. *Erythrus apiculatus* (Pasc.) var.	*Lycostomus gestroi* (Bourg.).	
		30. „ *rotundicollis* (Gahan)	„ „ „	
		31. „ *sternalis* (Gahan)	„ „ „	
		32 „ *biapicatus* (Gahan)	*Metriorrhynchus kirschi* (C. Waterh.).	
		33. *Pyrestes eximius* (Pasc.)	„ *dispar* (C. Waterh.).	
		34. *Erythrus viridipennis* (Gahan)	*Prionocerus cæruleipennis* (Perty).	Fam. MELYRIDÆ.
	Subfam. *Sestyrinæ.*	35. *Collyrodes lacordairei* (Pasc.) *	*Collyris* sp.	Fam. CICINDELIDÆ.
	Subfam. *Clytinæ.*	36. *Sclethrus amœnus* (Gory)	*Tricondyla gibba* (Chaud.), var. *cyanipes.*	

XXIII. fig. 40, no. 17 in Table I.), with its swollen pedunculate posterior femora and white-tipped wings, resembles very closely the common little Dammar-bee *Melipona vidua* (Lepel.) (Plate XXIII. fig. 41); it is remarkably active on the wing and has doubtless often been passed over by collectors, the least important of its foes. *E. sarawakensis* (18) Wallace found crawling on timber, and stated "that they were remarkably ant-like"; in this species the posterior femora are not swollen.

Of the *Tillomorphinæ*, *Clytellus westwoodi* (20) and *Halme cleriformis* (19) are almost indistinguishable from ants.

Notes on Table II.—*Longicorns mimicking other Coleoptera.*

Excluding, for reasons already mentioned, the subfamilies *Mesosinæ* and *Apomecyninæ*, it will be seen that the *Saperdinæ* and *Astatheinæ* are essentially the mimetic subfamilies in this section. Most of the species are extremely common and highly conspicuous, and I have little doubt but that all are distasteful, and therefore furnish examples of synaposematic coloration (Müllerian mimicry). All the species of the genus *Entelopes* are mimetic. *E. glauca* (Guér.), red with black spots (Plate XXIII. fig. 32), is quite Coccinellid in appearance (compare fig. 30), though more by virtue of its markings than of its shape. This association of red colour with black spots is so typically a warning coloration, as exemplified by scores of species of Coccinellidæ, that it is impossible to regard the same pattern on a Longicorn as anything but pseudaposematic or synaposematic. *Entelopes* n. sp. near *wallacei* (Pasc.), an entirely reddish-fulvous species, has as its model similarly coloured species of the family Galerucidæ, *Metrioidea apicalis* (compare figs. 13 & 14, Plate XX.), which, as will be seen, serves also as model for two species of the *Astatheinæ*. *Entelopes ioptera* (Pasc.), with its yellow prothorax and blue elytra, and *Entelopes amœna* (Plate XX. fig. 26), with reddish prothorax and blue elytra, also find parallels amongst the distasteful Galerucidæ (see the accompanying Table, pp. 242, 243; also Plate XX. fig. 25). *Serixia modesta* (Pasc.) and *S. lychnura* (Pasc.) are unlike any distasteful species with which I am acquainted; the closely-allied *S. prolata* (Plate XX. fig. 12) and *S. aurulenta* (Pasc.) mimic a small reddish-fulvous Galerucid, *Ænidia* sp. (Plate XX. fig. 11). The genus *Xyaste* is interesting as it mimics beetles of quite a different nature—the Lycidæ, whose distastefulness I have proved by repeated trials with various small mammals and birds. *Xyaste* is generically separated from *Serixia* by the thickened and pilose basal joints of the antennæ; the remaining joints, being of exceeding fineness, are more or less inconspicuous; and it is by this means that the thickened, flabellate, and short antennæ of the Lycidæ are simulated, whilst *Ephies dilaticornis* (Plate XXIII. fig. 18) and *Erythrus apiculatus* var. (Plate XXIII. fig. 8), also mimetic of Lycidæ, have the antennæ shortened and dilated in almost the same manner as their

models. *Xyaste invida* (Plate XXIII. fig. 26) and *X. fumosa* (Plate XXIII. fig. 25) are black with the basal half of the elytra reddish; a similarly coloured Lycid model, *Melampyrus acutangulus* (Bourg.) (Plate XXIII. fig. 23), is common round Kuching. *X. torrida* (Pasc.) is brownish-testaceous with a corresponding brownish-testaceous model—*Ditoneces* sp. (Plate XXIII. fig. 29). Of the Astatheinæ, *Astathes unicolor* (Pasc.) (=*coccinea* Pasc.), a large species with purplish reflections on the elytra (Plate XX. fig. 18), has unmistakable models in similarly coloured Galerucids —*Antipha* sp. and *Ochralea nigripes* (Plate XX. fig. 17). The next three species—*A. posticalis* (Plate XX. fig. 22), *A. flaviventris* (Pasc.), *A. splendida* (Plate XX. fig. 20)—all closely resemble each other, being dark shining blue anteriorly, red posteriorly; *flaviventris*, as its name signifies, has a yellow abdomen, whilst *splendida* has a red head and prothorax. The latter species mimics an equally resplendent Galerucid—*Caritheca mouhoti* (Plate XX. fig. 19), and the slight differences between *A. flaviventris* and *A. posticalis* are paralleled in two closely-allied Galerucidæ—*Antipha abdominalis* (Jac.) and *A. ?nigra* (Alld.) var. (Plate XX. fig. 21), the former of which alone has a yellow abdomen. *A. caloptera* (Pasc.), a blue species, finds a model in *Haplosonyx albicornis* (Wied.) (compare figs. 23 & 24, Plate XX., and see explanation of this Plate for a few further examples given in Table II. but not again mentioned in the text).

The remaining genera of the subfamily, as represented in Borneo, have corresponding models, also among the Galerucidæ, the resemblance between *Ochrocesis evanida* (Pasc.) and its model, *Hoplasoma unicolor* (Ill.) var. *ventralis* (Baly), being very exact. All these genera—*Tropimetopa*, *Chreonoma*, and *Ochrocesis*—are unicolorous, and form with the unicolorous *Saperdinæ* and numerous[1] Galerucidæ and Halticidæ a large group of similarly coloured beetles, all of which I consider to be distasteful.

The subfamily *Hippopsinæ* contains four species, each mimetic of a species of the Rhynchophorous family Brenthidæ. The first, *Alibora* sp., mimics *Baryrrhynchus dehiscens* (Sch.) (compare fig. 3 with 1 & 2, Plate XX.). The general colour of both model and mimic is a rich chestnut-brown, variegated on the elytra with bright yellow streaks and spots; the three basal joints of the antennæ of the Longicorn are clothed biramously with long and close-set hairs. In the natural attitude the elongated scapes are closely pressed together, the remaining joints gradually diverging, the result being a remarkable resemblance to the head with its elongated rostrum and shorter antennæ of the Brenthid, which only a closer examination proves to be deceptive; the short legs of the mimic add still further to the resemblance.

All the other three species of *Hippopsinæ* mimic extremely common species of the Brenthid genus *Diurus* (Plate XX.

[1] I have not included in the table all the unicolorous Galerucidæ and Halticidæ with which I am acquainted; those that are included are merely typical examples.

figs. 4, 5, 6). The Brenthids are extremely variable in both sexes, in the matter of size, in the shape and length of the terminal processes of the elytra, and in the amount of scaling on the head and antennæ. The three species here noted range in length from ·75 in. to 1·5 in.; and it is of exceptional interest that three mimetic Longicorns of sizes corresponding closely to these forms should be found in a more or less closely circumscribed area, and all belonging to the same subfamily.

In the first couple *Diurus sylvanus* (Senna) (a female) measures 1·5 in. in length, and the mimic *Ægoprepis insignis* (Pasc.) is of corresponding length (compare figs. 4 & 7 on Plate XX.). Both species are dark brown, relieved with pale ochreous streaks and spots; the Brenthid has the prothorax and elytra densely and deeply punctured, the punctures on the elytra being arranged in close-set rows. Both on the prothorax and elytra each puncture is occupied by a peculiar scale, lenticular in shape and pale ochreous in colour; these produce the pale ochreous streaks characteristic of the beetle (fig. 4 a). The head and antennæ are covered by similar scales, more closely set and not imbedded in punctures; each elytron terminates in a somewhat sharp point, the homologues of the long, narrow, terminal processes of the male.

The mimic has the ground-colour of the prothorax and elytra black, and their dorsal surfaces are covered with tufts of a fine pale ochreous pubescence (fig. 7 a); these represent very well the scales of the Brenthid, and a very similar mottled appearance is thus produced in both species by totally different means. The elytra of the Longicorn do not terminate in sharp points corresponding to the points of the Brenthid's elytra, as in the two species mentioned below. The rostrum of the model is slightly longer than in *Baryrhynchus dehiscens*, but the antennæ are shorter and thicker; and similarly we find that the antennæ of the mimic, which, when carried in the natural attitude (*i. e.*, pointing forward and closely apposed), simulate the rostrum and antennæ of the Brenthid, are plumose for a greater part of their length than in *Alibora* sp., whilst the free portion is short and thick, not long and setaceous as in the *Alibora*. Both model and mimic were taken on a fallen log close together.

Ectatosia moorei (Pasc.) is a mimic of *D. shelfordi* (Senna) (♀), a species of medium size, 1 inch in length (compare fig. 10 with 6 and 10 a with 4 a on Plate XX.). The simulation is as perfectly carried out and by the same means as in *Ægoprepis insignis*, with this addition, that the elytra terminate in sharp points corresponding to the same points in the Brenthid. The length of the mimic from elytra tips to termination of the plumosity of the antennæ is approximately the same as the length of the model from elytra tips to tip of the rostrum.

Another and a smaller species, *Dymascus porosus* (Pasc.) (Plate XX. fig. 9), mimics—again by the same means—a small *Diurus forcipatus* (Westw.) measuring only ·75 inch in total length

(fig. 5). The model may be a male or female, as in such small-sized specimens the male does not bear the long elytral processes characteristic of large or medium-sized varieties, the elytra are merely produced into short points; these short points are mimicked by the Longicorn very exactly.

Stegenus dactylon (Pasc.) of the subfamily *Agniinæ* is also a fair mimic of a large-sized *Diurus sylvanus* (compare figs. 8 & 4 on Plate XX.). As in *Ægoprepis insignis*, the body is blackish-brown streaked with a pale ochreous pubescence (fig. 8 a); the basal two-thirds of the antennæ are clothed with a dense black plumosity; the remaining joints are ochreous and pale in colour.

Elelea concinna (Pasc.), one of the *Mesosinæ*, also mimics in the same manner a small Brenthid, *Arrhenodes* sp., as previously noted by Wallace, who remarks that it carried its antennæ "straight and close together, appearing like a Brenthid."

Another of the *Mesosinæ*—*Zelota spathomelina* (described by Mr. Gahan in Appendix I. to this memoir)—mimics an Endomychid, a species of *Spathomeles* near *turritus* (Gerst.) (compare figs. 57 & 56, Plate XXIII.). The model, which is not represented in the British Museum collections, is pitchy-black with two reddish spots on each elytron; springing from each elytron is a stout spine directed somewhat forwards, forming a very efficient defence against the attacks of enemies. It is not improbable, moreover, that this beetle is still further protected by some distasteful properties, which, at any rate, are possessed by the species of the genus *Eumorphus* of the same family, an assemblage of black or purplish insects with conspicuous yellow spots. All of these possess a very pungent though not altogether disagreeable odour, whilst many exude a yellowish acid fluid when seized. The mimic of the *Spathomeles* is coloured in much the same way as its model: on each elytron there is a mamilliform prominence, from which springs a pointed tuft of delicate hairs, which is curved slightly forwards. These tufts so closely resemble the formidable spines of the model that a near inspection with lens and finger is necessary to reveal the deception. Another Endomychid beetle, *Amphisternus mucronatus* (Gerst.), is also a probable model of the same species of Longicorn.

The aberrant *Trachystola granulosa* (Pasc.), which was placed provisionally in the subfamily *Dorcadioninæ*, with its deeply punctured and granulate elytra, presents the general appearance of a large black Curculionid, such as *Sipalus granulatus* (Fab.), without, however, exhibiting any very highly modified mimetic characteristics, as in the species previously discussed.

Daphisia pulchella (Pasc.) is a highly conspicuous little beetle of the subfamily *Phytæciinæ*, and is almost indistinguishable from two species of Clerid of the genus *Callimerus* (compare fig. 55 with figs. 53 & 54 on Plate XXIII.).

[The resemblance of the Cleridæ as a group to widely different Coleoptera and to insects of other orders is well known. Looking

through the fine collection in the Hope Department, two chief types of deceptive coloration were seen to be predominant, viz., that of Mutillidæ and Cantharidæ. While the constant repetition of a single very distinctive Hymenopterous type is remarkable, it must not be forgotten that the Cantharid appearance, orange with black transverse bands, is furthermore strongly suggestive of one of the commonest and most conspicuous types of colouring in the Hymenoptera Aculeata. In addition to these predominant types other deceptive resemblances were common, viz., to Phytophaga, Lycidæ, ants, and apparently, in the case of certain Australian species, to Cetoniidæ. All the species of the interesting genus *Allochotes* (Westw.) were Coccinelliform. The interesting question arises as to whether these resemblances are Batesian (pseudaposematic) or Müllerian (synaposematic). The latter interpretation is strongly supported by the interesting discovery by Mr. Shelford of the mimicry by the Longicorn *Daphisia* of two species of the Clerid genus *Callimerus*, possessing an independent warning coloration. The conspicuous appearance, abundance, and habits of the species of this genus are entirely consistent with the explanation of their colours and pattern as aposematic. Fig. 49 on Plate XXIII. shows a Clerid, *Tillicera* sp., resembling a Mutillid, near *Urania* (Sm.) (fig. 48); fig. 52 a Clerid, *Tenerus sulcipennis* (Gahan), resembling a Lycid, *Metriorrhynchus atrofuscus* (fig. 50 & 51); while figs. 53 and 54 show the Clerid species of *Callimerus* resembled by the Longicorn. The whole group was obtained by Mr. Shelford from the vicinity of Kuching, and it strongly suggests that the Clerid mimics (figs. 49 & 52) are really synaposematic.—E. B. P.]

In the Cerambycidæ, *Collyrodes lacordairei* (Pasc.) is the most remarkable mimic of the Cicindelan genus *Collyris*. *Sclethrus amœnus* (Gory) is also remarkably like the genera *Tricondyla* and *Collyris* with its dark blue body and bright red legs, of which the hind pair are considerably elongated (compare fig. 11 with 5 and 3 on Plate XIX.). It is much less common than its model, but is found in the same situations and always tries to escape its captor by running swiftly just like the *Tricondyla*. The other five species mentioned in this section of the table, *Ephies dilaticornis* (Pasc.), the three species of *Erythrus*, and *Pyrestes eximius* (Pasc.), mimic species of the Lycidæ (see group of figs. 4 to 8, 12, 19, Plate XXIII.). *P. eximius* with its elongated prothorax is perhaps less Lycid in appearance than the other species.

Erythrus viridipennis, with black head, red thorax, and green elytra, is a mimic of one of the Melyridæ, similarly coloured, *Prionocerus cœruleipennis* (Perty) (Plate XXIII. figs. 58 & 59). All these species of *Erythrus* were taken in great abundance on Mt. Matang, and I am strongly of opinion that the entire subfamily *Pyrestinæ* is a distasteful one: the mimicry in this case is therefore Müllerian. *Ephies dilaticornis*, on the other hand, I am inclined to regard as a Batesian mimic; it is rare, a closer mimic, and belongs to an essentially mimetic subfamily (*cf.* Table III.).

TABLE III.—*Longicorns mimicking Longicorns.*

Family	Subfamily	Mimics.	Models.	Subfamily
Fam. LAMIIDÆ.	Subfam. *Acanthocininæ.*	1. *Driopea clytina* (Pasc.)*	*Clytanthus* sp.	Subfam. *Clytinæ.*
	Subfam. *Lamiinæ.*	2. *Cylindrepomus peregrinus* (Pasc.)	*Xylotrechus pedestris* (Pasc.).	
		3. ,, *comis* (Pasc.) & sp. near it	*Chlorophorus (Clytanthus) annularis* (Pasc.).	
	Subfam. *Saperdinæ.*	4. Gen. ? and sp. ?	*Chloridolum thomsoni* (Pasc.) & sp. near it.	Subfam. *Callichrominæ.*
	Subfam. *Phytæciinæ.*	5. *Daphisia* sp.	*Chlorophorus annularis* (Pasc.).	Subfam. *Clytinæ.*
		6. ,, sp.	*Demonax viverra* (Pasc.).	
		7. *Ossonis clytomina* (Pasc.)	*Clytanthus sumatrensis* (Lap. & Gor.).	
		8. *Cryllis clytoides* (Pasc.)	,, ,, ,,	
		9. *Chlorisanis viridis* (Pasc.)*	*Chloridolum thomsoni* (Pasc.) & sp. near it.	Subfam. *Callichrominæ.*
Fam. CERAMBYCIDÆ.	Subfam. *Œmiinæ.*	10. *Xystrocera alcyonea* (Pasc.)	*Chloridolum thomsoni* (Pasc.) & sp. near it.	
	Subfam. *Disteniinæ.*	11. *Psalanta chalybeata* (Pasc.)*	*Chloridolum* sp.	
	Subfam. *Lepturinæ.*	12. *Leptura* probably n. sp.	*Chloridolum cinnyris* (Pasc.).	
		13. ,, sp. near *histrionica* (Pasc.)	*Xylotrechus decoratus* (Pasc.).	Subfam. *Clytinæ.*
		14. ,, sp.	*Demonax mustela* (Pasc.).	
	Subfam. *Glaucytinæ.*	15. *Polyphida clytoides* (Pasc.)*	*Demonax viverra* (Pasc.).	

In the Cerambycidæ, the antennæ present great diversity of form—flabellate in *Cyriopalus*, thickened in *Epipedocera* and *Ephies*, short in *Demonax*, *Clytus*, and many other genera, enormously elongate in *Neocerambyx æneas*; and we find, perhaps as a consequence of this plasticity of the antennal form, a close resemblance in structure and external appearance between the antennæ of the mimetic Cerambycidæ and their models (*e. g.*, compare antennæ of *Nothopeus intermedius* and *Ephies dilaticornis* (Pasc.) with the antennæ of *Salius aurosericeus* and the Lycid *Metriorrhynchus kirschi* (C. Waterh.) respectively): whereas in the family Lamiidæ, nearly all the members of which are characterized by setaceous or linear antennæ, the simulation of the differently constructed antennæ of their models, if attained at all, is not brought about by actual resemblances in form, but by such devices as pilosities, modes of holding, or the thinning away of a portion of the length until it becomes almost invisible in comparison with a specially thickened portion (compare the antennæ of *Alibora*, *Ægoprepis*, &c., and of *Xyaste invida* with those of their respective models).

Notes on Table III.—*Longicorns mimicking Longicorns.*

The only two subfamilies of the Longicornia which serve as models to the other subfamilies are the *Callichrominæ*, a group of metallic-green beetles protected by a powerful odour, which is produced by glands behind the metasternum opening to the exterior by two pores, and the *Clytinæ*. This latter subfamily includes the well-known *Clytus arietis* (L.), mentioned in many works on natural history as mimetic of a wasp. Whether this is a case of Müllerian or of Batesian mimicry can only be proved by experiment, but I am quite confident that the Bornean representatives of the group are all highly distasteful. The extremely conspicuous and strikingly coloured *Chlorophorus* (*Clytanthus*) *annularis* (Plate XX. fig. 31) was the commonest beetle on Mt. Penrissen at all elevations: some shrubs simply swarmed with it, while its movements and its very presence in such numbers spoke eloquently of some protective characteristic. Species of the genus *Demonax* were almost equally common on the mountain, whilst around Kuching the species *Clytanthus sumatrensis* (Plate XX. fig. 37) and *Demonax viverra* (Plate XX. fig. 35) are amongst the commonest Longicorns met with. Such few experiments as I have conducted have yielded negative results. During my collecting expedition to Mt. Penrissen I naturally had no tame animals with me, and therefore was unable to experiment with *Chlorophorus annularis*, whilst in Kuching the species of *Demonax* and *Clytanthus*, though common enough, are never obtainable in large enough quantities at one time, a very necessary consideration when one experiments with that most inquisitive of animals, the common Macaque (*Macacus cynomolgus*),

which will devour a single specimen of beetle or butterfly entirely for the sake of curiosity, only manifesting disgust or the reverse when that curiosity is fully satisfied.

Of the mimicking species it is not necessary to say much, their resemblances to their models being in every case most obvious.

Amongst the Lamiidæ, the *Phytæciinæ* again yield the majority of mimetic species (a newly-discovered *Daphisia*, yellow in colour, is banded with black in almost identically the same manner as *C. annularis*) (compare figs. 34 & 31 on Plate XX.); and amongst the Cerambycidæ, the *Lepturinæ* are also fruitful in this respect. One species of *Leptura*, with reddish head and prothorax and yellow black-banded elytra, is closely similar to *Demonax mustela* (compare figs. 40 & 39, Plate XX.): another species allied to *Leptura histrionica* (Pasc.), black with cream-coloured bands, is not readily distinguishable from *Xylotrechus decoratus* (compare figs. 42 & 41) and one or two species of *Demonax*. Plate XX. and its explanation should be consulted for the representation of other examples given in Table III. but not further indicated in the text. *Polyphida clytoides* (Pasc.), *Psalanta chalybeata* (Pasc.), and *Chlorisanis viridis* (Pasc.) I have never seen, but good figures of them are published in Pascoe's paper on the Longicornia Malayana (Trans. Ent. Soc. ser. 3, vol. iii.). The remaining mimics of the iridescent green *Callichrominæ*, viz. Nos. (4), (10), and (12) in Table III., are shown in figs. 47, 48, and 44 on Plate XX. and their models in figs. 45, 46, and 43.

[The mimetic resemblance to the *Clytinæ* exhibited by so namy species of distantly related Bornean Longicorns is of extreme interest. The widespread species of this dominant group have developed, in a great majority of cases, a black and yellow or black and orange transverse banding, which superficially resembles the characteristic appearance of wasps and hornets. This rough resemblance is further heightened by the active movements of the living beetle, which suggest those of a Hymenopterous rather than a Coleopterous insect. Such an appearance is found in *Clytinæ* of many species from the whole Palæarctic and Nearctic belt, from Mexico, Malaya, Australia, and probably many other countries. An Australian species, *Aridæus thoracicus* (Donovan), has the deep brownish-orange colour of the alternate stripes, as well as the comparatively few broad black bands which are characteristic of wasps from the same region. *Clytanthus sex-guttatus* (Lucas) from Morocco suggests the appearance of a Mutillid or perhaps a Clerid with a Mutillid form of colouring. The Bornean *Sclethrus amœnus* (Gory) mimics the aggressive Coleopterous *Tricondyla* (Cicindelidæ), while species of the *Tillomorphinæ*, allied to the *Clytinæ*, mimic ants, e. g., *Euderces picipes* (Fab.) of N. America and *Clytellus westwoodi* (Pasc.) of Borneo. Thus we witness within the limits of one large group of Coleoptera a great development of mimicry of aggressive specially protected forms. Such mimicry has been hitherto assumed to be Batesian (pseudaposematic), although the dominance

of the group in which it is manifest, the abundance and wide range of individuals in the species as well as of the species themselves, together with the remarkable predominance of mimetic resemblances among them—all tended to create a strong suspicion that the mimicry is Müllerian (synaposematic). This suspicion is now justified. The discovery of many Bornean Longicorn mimics of *Clytinæ* renders it in every way probable that the group is specially defended by some unpalatable quality, and sometimes develops warning colours of its own which are deceptively resembled by other beetles, although it usually makes use of warning colours which are common to more aggressive and even more highly-protected insects. Thus the conclusions which were found to hold in the case of the Cleridæ (p. 248) also apply, with equal probability, to the *Clytinæ*. Since the above was written Mr. Gahan has shown me a beautiful example of Batesian or Müllerian mimicry within the group of *Clytinæ*, the common *Demonax walkeri* (Pasc.) being resembled in the closest manner by the rarer *Perissus myops* (Chev.). Both beetles had come to the British Museum in a single consignment from Ceylon. There is similarly a very remarkable resemblance, probably Müllerian, between *Xylotrechus pedestris* and *Demonax viverra* (compare figs. 29 & 35 on Plate XX.).—E. B. P.]

Coleoptera other than Longicorns as Mimics.

Mimic. *Tillicera* sp., near *bibalteata* (Gorh.) (Fam. Cleridæ). Plate XXIII. fig. 49.

Model. *Mutilla* sp. near *urania* (Sm.). Plate XXIII. fig. 48.

The *Mutilla* has a red head and thorax and black abdomen, the second abdominal segment bears a white spot, the third segment is covered with a creamy white pubescence. In the beetle, the eyes and front of head are black, the vertex of the head and the prothorax are red; the elytra are black with one white band replacing the white spot and another sub-apical band paralleling the white abdominal segment of the *Mutilla*. Curiously enough, the male of this species of *Mutilla* bears a white band in place of a white spot, and hence the beetle more closely approaches the male than the female in its markings: still there is no question as to which sex serves as the model in this case.

Several specimens of the same species of *Tillicera* and of a closely-allied one are in the Hope Collection, Oxford, all collected by Dr. A. R. Wallace in Sarawak.

IV. LEPIDOPTERA AS MIMICS.

So much has been written, by abler pens than mine, on mimicry amongst the Eastern Lepidoptera *inter se*, that I have confined myself to drawing up merely a table of such mimetic species as occur in Borneo, with the addition of a few notes on the bionomics of certain species. Three remarkable examples of lepidopterous

mimics which came under my observation—namely, a sphingid larva mimicking a snake, a noctuid larva mimicking an ant, a moth mimicking a plant-bug—deserve, however, further notice and are here described at length.

i. **Mimic.** Larva of *Chœrocampa mydon* (Walk.).
Model. A Snake, e. g. *Dendrophis picta* (Gm.).

I must confess that I have always hitherto regarded as somewhat fanciful those recorded cases of lepidopterous larvæ mimicking snakes and other vertebrate animals, though experiments have shown that the resemblances, even when imperfect, serve to rouse respectful curiosity, if not actual terror, in prospective enemies. I was therefore singularly delighted to secure a larva whose resemblance to a snake was so startlingly accurate that I was for a moment completely deceived.

The general colour was a dark olive-brown, becoming lighter anteriorly: the head, the first and second and the dorsal surface of the third and fourth segments were pinkish; at the junction of the third and fourth segments on each side was an ocellus, not a huge black disc, out of all proportion to the mimicked head, as in all the recorded similar examples, but of very nearly the exact size of the eye in such a snake as *Dendrophis picta*: the lower border of this was margined with bright gold (the colour of the iris in many snakes), giving an upward look and a most malevolent cast to the countenance; the black of the ocellus was so intense and glossy that an idea of depth was given, and it was difficult to believe that one was not looking through a cornea into a pupil. Running through the ocellus on each side was a broad black stripe exactly as in *Dendrophis picta*, while a wrinkled fold on each side of the lower half of the second, third, and fourth segments gave an admirable impression of the division between the upper and lower jaws of a snake. Not the least remarkable of these extraordinary devices was the flatness of the area bounded by the two "eye-stripes" on the dorsal surface of the third and fourth segments; this area together with the first and second segments were pink, reticulated with fine brown lines and strokes, giving an impression of the scutes on a snake's head; they were particularly well-marked on the first and second segments, being there more distant and distinct, and looking extremely like the divisions between internasal and præfrontal shields.

When the larva was moving about with the anterior segments well expanded, the resemblance to a snake was not so startling, but directly it was touched the terrifying attitude was assumed, the anterior segments being drawn in and the front of the body turned towards the aggressor; when, at the same time, the posterior part of the body was hidden by leaves the deception became complete, and if effective enough to deceive, even temporarily, a human being, it must surely be equally effective in deterring less highly organized and more timid foes.

Unfortunately I was unable to test the efficacy of the disguise for fear of losing the larva, which I was anxious to rear for the purpose of identification.

ii. **Mimic.** *Larva of a Noctuid Moth* (? Genus *Tinolius*).
Model. An Ant, *Œcophylla smaragdina* (Fab.).

In Jan. 1900 a curious Noctuid larva of the subfamily *Quadrifinæ* was pointed out to me by Mr. H. N. Ridley in the Botanic Gardens, Singapore, resting on a leaf of a tree much frequented by the common red ant *Œcophylla smaragdina.*

Nearly all the segments of the body are furnished with fragile tentacle-like processes which are capable of quivering movements, and so loosely attached that very careful handling was necessary to secure a perfect specimen.

The arrangement of these tentacles is as follows:—

Segment 1. 3 pairs: 1 pair lateral, 2 pairs dorsal pointing forwards.
,, 2. 3 pairs: 1 pair lateral, 1 pair sub-lateral, 1 pair dorsal.
,, 3. 2 pairs lateral.
,, 4. Unprovided with tentacles.
,, 5–10. Each with 1 lateral pair.
,, 11. 2 lateral pairs.
,, 12. 1 lateral pair.
,, 13. 2 lateral pairs, the most anterior being very delicate, the most posterior strong and curved backwards.

Segment 8 is dorsally produced into a sharp-edged prominence. The anal prolegs are somewhat disproportionately large and can be widely divaricated; just above each is a prominent black spot: the colour of the body is brown of the exact shade of the *Œcophylla*, with a narrow yellow line on each side. When the larva is irritated, the posterior part of the body is immediately reared in the air, the anal prolegs are thrown widely apart and the tentacles, especially the most posterior pair, are violently agitated. When the caterpillar is seen in an end-on position or when the anterior two-thirds of the body are hidden, the resemblance to the ant is positively startling: the black eye-spots represent the eyes, the widely-diverging anal prolegs, the gaping jaws and the tentacles, the antennæ and legs of the model; the posterior pair of tentacles are so curved that they represent very accurately the elbowed antennæ of the ant.

It might be thought essential, in cases of mimetic lepidopterous larvæ such as the two examples just described, that the greater part of the body should be concealed in order perfectly to deceive prospective enemies: for example, in the sphinx-moth larva it is only the head of the snake that is copied, but is it necessary for the larva, in order to obtain immunity, that it should conceal its disproportionate shortness of body, thus arguing for it a degree

of appreciation of its shortcomings with which such lowly organisms are not usually credited? It seems to me more reasonable to compare such mimetic examples to the pictures of a painter, who strives not to make an exact copy of a scene or object, but to give an essential idea or impression of it, unintelligible perhaps to many, but full of significance to those for whom a picture is more than a mere photograph in colours.

[It is not necessary to adopt the improbable view that the caterpillar has any "appreciation" of the situation, even if we may reasonably believe that the mimetic resemblance is aided by partial concealment. A larva living among leaves is apt to be partially concealed by them and to be protected by the concealment. The appropriate attitude would arise through natural selection without the intervention of intelligence on the part of the larva.—E. B. P.]

The *Œcophylla*, one would imagine, has firmly established a reputation for ferocity, and consequently the mimicking Geometer larva can the more easily deceive its enemies, in spite of its too elongate body. Only two specimens were found, both were walking on leaves and were readily distinguishable; but the violently threatening attitude each assumed when irritated was unmistakable, and the resemblance of the elevated posterior end to the ant so striking, that it is difficult to imagine how a lizard or frog with a previous experience of the ant could fail to be deterred.

I shall have later to draw attention to a Spider which mimics the same ant, but this is a case with a different significance, viz., that the mimic may be enabled to prey undisturbed on its model.

It is a curious coincidence that, in both the larva and the spider, it is the posterior end that mimics the head of the ant—a coincidence which possibly has its meaning.

iii. **Mimic.** *Phauda limbata* (Wllngrn.). Plate XXIII. fig. 3.
Model. *Serinetha abdominalis* (Fab.). Plate XXIII. fig. 2.

The head, thorax, and coriaceous part of the elytra are, in this Hemipteron, of a bright vermilion-red, whilst the membranous part of the elytra, the legs, and antennæ are black. The moth has the head, thorax, costal margin, and basal half of the fore wings also vermilion, with the remaining portion black, the hind wings are coloured in the same way. I had long been familiar with the moth from cabinet specimens, but until I went to Singapore and saw the insect alive I had not suspected the significance of this very striking coloration. When the moth is in a state of repose, resting, for example, on a plant-stem, the wings are laid back and overlap in the characteristic moth-like manner, and in this attitude the resemblance to the bug is very striking (compare figs. 3 & 2, Plate XXIII.). The hind wings, although entirely hidden, nevertheless serve the purpose of giving an impression of complete opacity to the fore wings, the red and black areas of which in this attitude overlap the similar areas of

TABLE IV.—*The Pseudaposematic and Synaposematic Species of Bornean Lepidoptera.*

Models.	Mimics.				
Subfam. *Danainæ.*	Subfam. *Nymphalinæ* [? pseudaposematic].	Subfam. *Elymniinæ* [pseudaposematic].	Subfam. *Papilioninæ* [chiefly pseudaposematic].	Subfam. *Pierinæ* [synaposematic].	Subfam. *Chalcosiinæ* [synaposematic].
Ideopsis daos	....	....	*Papilio delesserti* ♀	....	*Isbarta pieridoides* (Herr-Schäff.).
Radena vulgaris	*Euripus halitherses* ♂ ...	*Elymnias lais* ♂	*Papilio megarus.*		
Radena juventa	....	....	*Papilio delesserti* ♂.		
Limnas chrysippus	*Hypolimnas misippus* ♀.				
Tirumala septentrionis.	....	....	*Pap. macareus macaristus.*		
Bahora aspasia	....	....	....	*Nepheronia lutescens* ♀.	
Caduga larissa .... *Parantica eryx*	....	*Elymnias lais* ♂.			
Tronga crameri	*Hypolimnas anomala* ♂.	*Elymnias aroa*, n. sp.	*P. paradoxus telesicles* ♀, var. *russus.* *P. paradoxus telesicles* ♀, var. *leucothoides.* *P. leucothoe ramaceus.*	....	*Isbarta macularia* ♀.
Adigama scudderi	....	....	....	....	*Amesia hyala.*
Penoa zonata	....	....	*Pap. slateri hewitsoni.*		
Penoa menetriesii	....	*Elymnias lutescens*...	....	....	*Mimeuplœa tristis* (Jordan).
Trepsichrois mulciber ♂	*Euripus halitherses* ♀, var. *cinnamomeus.* *Hypolimnas anomala* ♀	*Elymnias borneensis.*	*Pap. paradoxus telesicles* ♂.	....	*Pompelon subcyanea.* *Callamesia striata* ♂.
" " ♀	....	*Elymnias lais* ♀	*Pap. paradoxus telesicles* ♀.	....	*Callamesia striata* ♀.

Daniscpa lowei ♂	*Euripus halitherses* ♀, var. *pfeifferæ*............	....	*Papilio caunus mendax* ♂.		*Mimeuplœa rhadamanthus.*
„ „ ♀	*Euripus halitherses* ♀, var. *euplœoides*	....	*Papilio caunus mendax* ♀.	....	
Isamia ægyptus	same models as those	of *E. crameri.*			
Subfam. *Pierinæ.*					
Delias pandemia.........	....	....	....	....	*Isbarta pandemia.*
Delias aglaia	....	*Elymnias godferyi* .	....	....	*Isbarta dissimulata.*
Delias cathara	....	....	....	....	*Callamesia pieridoides* (Walk.).
Delias singhapura	....	....	....	*Prioneris cornelia.*	
Terias sari or *T. nicobariensis.*	....	....	....	....	*Isbarta inclusus.*
Subfam. *Papilioninæ.*					
Papilio aristolochiæ antiphus..............	....	....	*Papilio polytes theseus* ♀.		
Papilio erebus...........	....	....	*P. memnon* ♀, var. *erebinus.*		
Papilio noctis	....	....	*Papilio memnon.*		
Fam. Agaristidæ.					
Scrobigera hesperioides.	*Cethosia hypsea*	....	....	....	*Eterusia obliquiaria.*
Fam. Geometridæ.					
Euschema subrepleta ...	....	....	....	....	*Canerces gloriosus.*

the hind wings. Both mimic and model were taken in daytime in the Botanic Gardens, Singapore, and both were equally conspicuous; subsequently both species were found in Sarawak [1].

The following species are discussed below:—

	Mimics.	Models.
Subfam. *Nymphalinæ.*	*Symbrenthia hippoclus* with the mountain forms. *S. hypatia* var. *hippocrene* and *S. hypselis* var. *balunda*.	Yellow-and-black *Neptis*, e. g. *N. hordonia*, *N. tiga* &c.
	Athyma spp.	White-and-black *Neptis*.
Fam. Lycænidæ.	*Thrix gama*	*Eoxylides tharis*.
	Poritia plateni *Araotes lapithis*	*Drupadia boisduvalii* var. *atra*. *Biduanda thesmia*.

Notes on Table IV.

The females of *Euripus halitherses* (D. & H.) are extremely variable, in fact no two specimens of the fine series of this species in the Sarawak Museum collection are exactly alike, and almost every specimen deserves a varietal name of its own, as has been done to a certain extent for the mimetic *Papilio paradoxus telesicles* (Feld.) by Rothschild & Jordan (Nov. Zool. vol. ii.).

It is possible, however, to distinguish three main groups. One, almost entirely dark blue, is a mimic of *Trepsichrois mulciber* (Cr.), and approximates to *E. cinnamomeus* (Wood-Mason). Another is dark brown with a blue gloss and an oblique discal white fascia on the fore wings and some white streaks on the hind wings, and is a close mimic of *Danisepa lowei* (Butl.) ♂; this group is nearest to *E. pfeifferæ* (Feld.). The third group, near *E. euplœoides* (Feld.), corresponds closely in coloration and markings with *Danisepa lowei* ♀. A considerable number of variations of this highly variable species have been separated into distinct species, but I prefer to regard these as merely varietal names.

The females of *Danisepa rhadamanthus* (Fab.) (the continental form of *Danisepa lowei*) have much more white on the upper side and are readily distinguishable from the Bornean representatives, though the males are practically indistinguishable. In accordance with this, the continental forms of *Euripus halitherses* ♀ of the *euplœoides* type have larger white markings on the upper side than the insular forms; I have not seen continental forms of *Isbarta rhadamanthus* (Fab.) or of *Papilio caunus* (Westw.), but I expect that a parallel variation will be found in these. It is curious that the almost identical males of *D. rhadamanthus* and *D. lowei* are extremely common in their respective localities, whilst, on the other hand, the female of *D. lowei* is very rare, and the very different female of *D. rhadamanthus* is as common as its male.

Hypolimnas anomala (Wall.) is very Euplœine in its flight as well as in appearance; it is not an uncommon species and the

[1] [A closely similar example of Müllerian mimicry was sent for exhibition to the Entomological Society in 1894 by Mr. G. A. J. Rothney (see Proc. Ent. Soc. Lond. 1894, p. xv). The species *Phauda flammans* (Walk.) and *Serinetha augur* (Fab.) were observed in abundance on roots and trunks of trees in Mysore in Nov. 1893 by Mr. Rothney.—E. B. P.]

resemblance is possibly synaposematic. There are, at any rate, some good grounds for supposing that *H. misippus* (L.) is a Müllerian mimic of *Limnas chrysippus* (L.). (See Poulton: "Mimicry in Butterflies of the Genus *Hypolimnas*," Proc. Am. Assoc. Adv. Sci. 1897, vol. xlvi. p. 242.)

Elymnias nigrescens (Butl.) and allied species are in India and elsewhere mimics of *Euplœinæ*; no *Euplœinæ* serving as models to *E. nigrescens* occur in Borneo, though the species is common enough. The subfamily *Elymniinæ* is an interesting one, as affording examples of species endowed with a double means of protection against the attacks of their enemies. The majority of the Bornean species are on the upper side good mimics of Euplœine or Pierine models, whilst on the under side they are mottled with grey and brown, so that when at rest they are indistinguishable from their surroundings.

Elymnias lais (Cr.) occurred on Mt. Penrissen, and I had ample opportunities of observing something of its habits. The male is black above with green streaks, a common type of coloration amongst the *Danainæ* (e. g., *Radena vulgaris* (Butl.), *Caduga larissa* (Feld.), *Parantica eryx* (Fab.), &c., &c.), whilst the under side is mottled. The female is a mimic of *Trepsichrois mulciber* (Cr.) ♀, but I have never seen this sex alive. The green-and-black Danaines *Caduga larissa* (Feld.) and *Parantica crowleyi* (Jenner Weir) were abundant on Mt. Penrissen, so much so, indeed, that after two days' collecting they were left in peace. Their flight was leisurely and flaunting, so that they were always readily distinguishable. Their mimic, the *Elymnias*, flew more rapidly, but even then attracted one's attention as being remarkably similar to its models. By the time one had realized the true nature of the insect, it had flown past and a critical moment was gone. If the butterfly was followed up, it would be seen to settle on some twig or stalk with the wings closed, but on coming up to close quarters one might search for it in vain; any sudden movement would cause it to dart away, displaying once again its Danaine coloration, to some other resting-place, and so the hunt would be continued *ad nauseam*.

Elymnias godferyi (Dist.) mimics *Delias aglaia* (Linn.), and has on the under side some appropriate yellow and red markings, which are, however, somewhat obscured by mottlings of brown. We have here, in fact, a species which is beginning to discard a uniform mottled under side in favour of brighter mimetic coloration, such as is seen in some species from New Guinea and the neighbouring islands, which mimic very closely on both surfaces of the wings Euplœine and Pierine butterflies, and have discarded entirely a protective coloration.

Elymnias aroa, sp. n., is described in Appendix I. to this paper: only two specimens were captured. It is a fairly good mimic of *Tronga crameri* (Lucas), which occurred with it.

The common day-flying moths the Agaristid *Scrobigera hesperioides* (Wlk.) and the Chalcosid *Eterusia obliquiaria* (Wlk.) are

closely similar in wing pattern and colour (compare figs. 7 & 8, Plate XXI.); their coloration recalls that of *Heliconius clysonymus* (Latr.) and *H. ricini* (L.) of S. America and of the common Oriental *Cethosia hypsea*.

[The majority of the Chalcosid synaposemes named in Table IV. are shown on Plate XXI., together with their Euplœine, Pierine, and Agaristid models. The resemblance to the *Pierinæ* is so much more striking and the patterns so much more detailed and varied on the under sides of the wings, that this aspect is alone represented in the case of both Pierine models and their Müllerian mimics (figs. 1 to 6, Plate XXI.). *Delias cathara* (Grose-Smith) is very rare, whilst its mimic *Callamesia pieridoides* (Wlk.) (compare figs. 5 & 6) is comparatively common, a fact which supports the Müllerian interpretation. A comparison of the whole series of Chalcosid mimics and their models leaves no doubt that the moth is the mimic and the butterfly the model, even though the former be common and the latter rare.—E. B. P.]

The species of *Symbrenthia* and of *Athyma* have a close resemblance to the Neptides, all of which are highly distasteful. The association in this case is probably Müllerian.

The extremely common Lycænidæ *Eoxylides tharis*, *Drupadia boisduvalii*, and *Biduanda thesmia* are mimicked by *Thrix gama*, by *Araotes lapithis*, and by *Poritia plateni*. In this case the mimicry is Batesian. Mr. de Nicéville, in his 'Butterflies of India,' vol. iii. p. 11, gives a list of mimetic Lycænidæ compiled by Doherty, but he informs me that Doherty conducted no experiments to prove the correctness of his association of the various species in mimetic examples. I am, however, quite certain that *E. tharis*, *D. boisduvalii*, and *B. thesmia* are distasteful species, whilst the great rarity of the mimicking species points to the conclusion that they are Batesian mimics.

V. DIPTERA AS MIMICS.

A complete list of the mimetic flies of Borneo would comprise at least one-third of the total number of species, but inasmuch as the literature on the Malayan Diptera and their Hymenopterous models is both scanty and scattered, I think it advisable to postpone the compilation and discussion of such a list until our knowledge of these two orders as represented in the East is increased and more systematized. I therefore select for special notice and description eight species only, each of which exhibits some noteworthy modifications of structure and habit, produced in the attainment of a likeness to its respective mimic.

i. **Mimic.** *Laphria* sp. near *terminalis* (v. d. Wulp). Plate XXII. fig. 10.

Model. *Salius sericosoma* (Smith). Plate XXII. fig. 9.

This large and handsome fly is not infrequently met with in the neighbourhood of Kuching, and the immunity which it

enjoys is doubtless due to the closeness of its resemblance to an equally conspicuous *Salius*, an ally of which has already been noted as the model of a Longicorn beetle. The fore wing of the *Laphria* is large, almost as broad as both fore and hind wing together of the *Salius* and of the same clear golden-brown. The thorax, as in the wasp, is covered dorsally with a golden pubescence, whilst the abdomen, like that of the model, is black, and terminates in a sharp tufted point very suggestive of a sting. All the tibiæ and tarsi are ochreous, but the black and thickened femora are very unlike those of the *Salius*. No attempt at mimicking the long ochreous antennæ of the wasp is made, as in some other Diptera shortly to be described (compare figs. 9 & 10, Plate XXII.). The buzzing, noisy flight of this fly is very like that of its model.

[In the natural attitude of rest it is probable that the black femora of the fly are held upright and near to the body, so that the ochreous parts of the legs would alone be conspicuous. It is noteworthy that the *under sides* of the anterior femora are ochreous, suggesting that the anterior limbs may in certain attitudes be raised, or, at any rate, that they are held so that this part is more conspicuous than any other femoral surface. It is probable that this special colouring is directed to meet a view from the front. It is to be hoped that future observations will be specially directed to these points. This fly belongs to the family of the Asilidæ (subfamily *Laphrinæ*), the most formidable and predaceous of Diptera, and it is quite possible that the resemblance to a wasp is Müllerian (synaposematic) rather than Batesian (pseudaposematic).—E. B. P.]

ii. **Mimic.** *Hyperechia fera* (v. d. Wulp). Plate XXII. fig. 2.
Model. *Xylocopa latipes* (Drury). Plate XXII. fig. 1.

No more remarkable proof of the plasticity of the Dipterous form could be advanced than this remarkable insect. The large, clumsy *Xylocopa*, with its bronzy wings and thick furry legs, would seem to be an eminently unsuitable and difficult model to copy; and it would be most instructive, if only it were possible, to trace the steps by which this fly has arrived at what at first sight appears to be the pitch of mimetic perfection. As a matter of fact the fly is extremely rare, and one can only conclude that the mimicry, exact though it seems, has failed to preserve the species as a dominant one.

The head is characteristically Dipterous; the thorax is of shining blue-black, clothed with a fine dense pubescence, coarser and longer on the sides; the broad, flattened abdomen is laterally bordered with a fringe of long hairs exactly as is the case with the *Xylocopa*, and terminates in a fine tufted process suggesting a sting. As in *X. latipes*, all the legs are remarkably hairy and sturdy, particularly the last pair, and are of much the same length. The wings are of a bluish-bronze hue: the downwardly-

curved submedian vein in the wing of the fly represents the junction between the fore and hind wings of the bee, and the areolet of the hind-wing of the bee also finds its parallel in the alula of the fly. The halteres are quite concealed amongst the hairs on the sides of the thorax. I have only seen one solitary specimen of this fly (Kuching, Feb. 1899), and have nothing to record of its habits beyond stating that both on the wing and at rest it was exceedingly difficult to distinguish from the common *X. latipes* (compare figs. 1 & 2, Plate XXII.).

[It is possible that the fly is constantly mistaken for a Xylocopid, and that it is not nearly so rare as it appears to be. The genus is widespread, and Mr. G. A. K. Marshall has sent me an equally beautiful example from Mashonaland. In this case the insect is unique (it has been recently described as *Hyperechia marshalli* (Austen)), but Mr. Marshall's notes clearly indicate the reason of its rarity. It must be remembered also that the extreme perfection of the resemblance is aided by the rapid flight and alertness of the fly. *Hyperechia* belongs to the same family and subfamily as the species last described, and here, too, the Müllerian interpretation must be taken into account. In fact Mr. Roland Trimen, to whom I showed the African specimen, expressed the opinion, from his experience of its allies, that it is a far more formidable insect than its model. The strengthening and curvature of the submedian vein in the fly's wing, which apparently represents the junction between the bee's fore and hind wings, is an instance of the attainment of a detail in the resemblance by a very slight alteration of form; for the vein in the last-described species of fly pursues nearly the same curved direction, although the line of junction of the wings of its model is nearly straight. In both species of fly there is a slight break in the even contour of the margin at the point where this vein reaches it, which is very suggestive of a junction between fore and hind wings, while the curve of the margin is changed on either side of the break in such a manner as further to promote the resemblance.—E. B. P.]

iii. **Mimic.** *Milesia vespoides* (Wlk.). Plate XXII. fig. 14.
Model. *Vespa cincta* (Fab.). Plate XXII. fig. 13.

The large wasp, black with a broad red band on the second abdominal segment, is closely mimicked by an equally large fly with the distal half of the second segment and the proximal half of the third segment coloured red. This red band, though actually occupying a different position from that of the wasp, is separated from the thorax by a black interspace nearly equal in breadth to the wasp's first abdominal segment, which is also black. The wings are similarly coloured in both species (compare figs. 13 & 14, Plate XXII.).

iv. **Mimic.** *Midas*, n. sp. (Fam. Midaidæ.) Plate XXII. fig. 12.
Model. *Macromeris violacea* (Lep.). Plate XXII. fig. 11.

Macromeris violacea, a dark blue fossorial wasp, with dark blue

wings resplendent with metallic blue sheen, occurs commonly on the mountains near Kuching. On Mt. Santubong a fly was recently captured affording a close resemblance to the wasp. The body and legs are exactly of the same shade of colour as are those of the wasp; the wings, though somewhat browner, are more opaque and possess a blue metallic sheen sufficiently deceptive. Their size is large (larger than the fore wing alone of the wasp), and it is interesting to note the same downward curve of the submedian vein as was found in *Hyperechia fera*, suggesting the line of junction between a fore and a hind wing. The antennæ are fairly long, though far shorter than those of the wasp. I have not seen this species in the living state, but even as a cabinet specimen it is a remarkable case of deceptive resemblance (compare figs. 11 & 12, Plate XXII.).

Specimens of this fly from the Philippines and Tenasserim are in the British Museum collection of Diptera.

v. **Mimic.** *Physocephala* sp. (Fam. Conopidæ.)
Model. *Ischnogaster micans* (Sauss.).

This example has been selected at hazard from a large number of similar thin-waisted flies, chiefly Syrphidæ and Conopidæ, as typical of the method by which the similarly built Eumenidæ and Vespidæ are mimicked. The first abdominal segment is much attenuated and drawn out, those following are thickened; the transparent wings are shaded with fuscous on their anterior borders, in accordance with a similar arrangement in the wasp; the head is the only part which exhibits any of the yellow colouring of the model.

vi. **Mimic.** Gen. et sp. ? (Fam. Stratiomyidæ, subfam. *Raphiocerinæ.*) Plate XXII. fig. 6.
Model. *Mesostenus* sp. near *pictus* (Smith). Plate XXII. fig. 5.

Both species were taken on Mt. Penrissen on the same day, and the similarity of their external appearance was equalled by the similarity of their method of flight and action when at rest. The Ichneumon-fly was common enough, and was frequently seen to hover over a plant for a few minutes, then suddenly drop down and pitch on to a leaf, over which it would walk, moving its white-banded antennæ up and down with a quick flickering movement. The fly, of which only one specimen was caught, behaved in exactly the same manner; it would hover, then suddenly settle and walk over a leaf on its mid and hind pairs of legs, waving rapidly up and down its long front legs, the tibiæ of which being black and the tarsi white, most closely resembled the antennæ of the Ichneumon-fly. The femora were kept more or less pressed against the ventral surface of the head, so that the sham antennæ seemed actually to arise from the correct position. This method of bringing about a resemblance to long antennæ is

also made use of by several species of *Calobata* and allied genera, but in the case here described the mimicry of an Ichneumon-fly is carried still further, inasmuch as the coloration is almost identical in both species, viz., black with yellow spots on the head and thorax, with alternate yellow bands on the abdomen, while the legs are ochreous with a black band at the apex of the femora and tibiæ. Furthermore, the ample clear wings are very similar in both mimic and model (compare figs. 5 & 6, Plate XXII.). The nearest allies of this remarkable fly occur in S. America.

vii. **Mimic.** ? *Xylophagus* sp. (Fam. Leptidæ.) Plate XXII. fig. 8.
Model. *Mesostenus* sp. Plate XXII. fig. 7.

This example is remarkable for the great elongation of the antennæ of the fly. In the previous case it was seen that the long antennæ of the model were represented by the fore legs of the mimic, but here there is an actual copy produced by means of a very unusual modification amongst the Diptera. The mimicry is so perfect that it will almost bear a close scrutiny through a lens; the large eyes, prominent clypeus, and maxillary palps of the fly give the head, even when thus closely examined, a characteristic Hymenopterous appearance. For the rest, the coloration is almost identical in both species: black with yellow spots and bands (compare figs. 7 & 8, Plate XXII.). The larva of the fly was found in decayed wood and presented no very extraordinary features.

viii. **Mimic.** *Sepedon* sp. near *javanicus* (Desv.). (Fam. Sciomyzidæ.) Plate XXII. fig. 4.
Model. *Collyris emarginata* (Macl.). Plate XXII. fig. 3.

It is not usual to find amongst the Diptera species which mimic any other order of insects than the Hymenoptera. This example and a species of *Celyphus*, which only very doubtfully can be considered as mimicking a small bug, are the only cases known to me.

Both of the species now under discussion were caught together on the wing on Mt. Serambu, Sarawak, and when seen alive and actively moving about were not readily distinguishable. As cabinet specimens they furnish an instance of the importance of field-work in the study of mimicry, and of the unreliability of dead impaled insects or mere figures unless, indeed, both are prepared with reference to careful observations of the living forms. The fly when alive was of a very brilliant blue like that of the *Collyris*, but the colour has now faded to a dusky indigo, while the abdomen being much shrunk detracts considerably from the previous resemblance. The legs are brilliant red, and constituted one of the most conspicuous features of both fly and beetle (compare figs. 3 & 4, Plate XXII.).

VI. RHYNCHOTA AS MIMICS.

α. Rhynchota Hemiptera.

i. **Mimic.** A *Reduviid*, sp.
Model. *Bracon*, sp.

The bug has the elytra, wings, and dorsal surface of the body reddish ochraceous as in certain common Braconidæ; the abdomen beneath is white; the apex of the coriaceous part of the elytra is black, thus resembling the black stigma on the fore wing of the model; while both elytra and wings are suffused with fuscous as in the model. So perfect is the resemblance between the two species that the bug was placed in a cabinet together with several other Hymenoptera, and the mistake was only discovered quite recently whilst attempting to arrange the museum collection of Braconidæ.

Another species, probably of the same genus of bug, mimics another similarly coloured species of *Bracon* in the same manner as above described.

[See also under section *Convergent Groups* for other examples of mimetic Hemiptera.]

β. Rhynchota Homoptera.

ii. **Mimic.** *Issus bruchoides* (Wlk.). Plate XIX. fig. 10.
Model. *Alcides*, sp. (Curculionidæ.) Plate XIX. fig. 9.

This remarkable little Homopteron, one example only of which is in the British Museum from Sumatra, occurs not uncommonly at Kuching on fallen logs or on living wood, whilst the Weevil is frequently found beneath the bark of fallen logs, sometimes in the very logs on the surface of which is found the mimic.

The whole appearance of the mimic with its hard convex elytra and deceptively powerful legs is very weevil-like, and the resemblance was evidently noted by the describer. The fore legs are much flattened and in side-view correspond closely in appearance to the powerful fore legs of the *Alcides* (compare figs. 9 & 10, Plate XIX.).

VII. SPIDERS[1] AS MIMICS.

i. **Mimic.** *Cyrtarachne conica* (O. Pickard-Cambridge).
Model. *A mollusc.*

The abdomen of this Spider is many times larger than the cephalothorax and is dorsally produced into a cone, which appears as if tilted backwards. The colour of the abdomen is creamy or yellowish white, marked with fine black and greenish lines and mottlings, arranged in a somewhat concentric manner so as to

[1] The Spiders here noted were described in P. Z. S. 1901, i. p. 11 *et seq.* pl. v. *Cyrtarachne conica* was wrongly recorded as occurring in Singapore.

represent very closely the whorls of a spirally coiled snail-shell, such as *Helix*.

The spider occurs in Kuching, and is generally found resting on leaves, sometimes with the cephalothorax turned right under the abdomen, in which position it is readily mistaken for a snail-shell, or with the cephalothorax in the normal position. In the latter case, if disturbed, this part of the body is immediately doubled under the abdomen and the animal usually rolls off the leaf, especially if a small one, and becomes lost in the decaying vegetation carpeting the ground below. I have been unable to discover any web, nor have I seen the manner in which the animal hunts or seizes its prey, but it seems probable that this is an example of one of those doubly significant devices whereby an animal is enabled not only to avoid its foes (in this case predatory wasps) but also to approach its own prey unobserved.

[It is possible that this resemblance is cryptic rather than mimetic. The former interpretation seems to be valid in the case of the British larva *Aspilates gilvaria*, which also resembles a snail-shell.—E. B. P.]

ii. **Mimic.** *Amyciaa lineatipes* (Pickard-Cambridge).
Model. *Œcophylla smaragdina* (Fab.).

I am indebted to Mr. H. N. Ridley for leave to incorporate in this paper the observations which he has made on this mimetic species, which as yet I have failed to find in Borneo. The ant under notice is an extremely common and ferocious species, chiefly remarkable for its nest-building habits. Mr. Ridley has described these habits in the Journal of the Asiatic Society, Straits Branch, 1890, No. 22, p. 345. The spider is of the same colour as the ant (reddish brown), and bears on the posterior part of the rather acutely pointed abdomen a pair of black eye-like spots, so that it is the abdomen of the spider which corresponds to the head, the cephalothorax to the abdomen of the ant. Both mimic and model are found together near the nest of the latter, and so close is the resemblance between the two that the spider is able to prey with impunity on the ants: I have taken a specimen of a spider with the body of an ant sucked nearly dry in its jaws; and Mr. Ridley has seen an individual pounce on an ant and then dropping from its foot-hold on a leaf, hang suspended by a silk thread in order to complete its meal in safety. No web is spun by the spider, but a round disc of silk, probably the egg-cocoon of this species, was found on the under surface of a leaf much frequented by the spider and its models.

iii. **Mimic.** *Salticus attenuatus* (Pickard-Cambridge).
Model. *An Ant.*

Mr. Ridley also sent me from Singapore a remarkable little Attid with a well-marked constriction about the middle of the

cephalothorax and a slender abdominal peduncle, so that the triple division of the insect-body is well imitated. The abdominal peduncle appears to bear a small scale and the abdomen is elongated; the elbowed antennæ of an ant are mimicked by the anterior pair of legs of the spider. I have not been informed whether this species, like the preceding, lives in company with its models.

VIII. CONVERGENT GROUPS.

There are certain combinations of colours in distasteful or otherwise specially protected insects which may be considered as warning: such are, black with yellow bands, black with one broad red band, black with white tips to the wings, yellow or red with black spots, red elytra or wings more or less broadly tipped with black; and we find insects, belonging to the most diverse orders, with one or other of these combinations of colours converging to a central form, a typical distasteful insect. Some of these converging forms may be non-immune and pseudaposematic (examples of Batesian mimicry); others may be distasteful themselves and synaposematic (examples of Müllerian mimicry). For example, all the Lycidæ are strongly distasteful, as I have proved by repeated experiments [1], and large numbers of them show the same type of coloration, the anterior third or two-thirds of the elytra being red, the posterior two-thirds or third black, whilst the head and thorax are black or red. Resembling the members of this group are ten species of Longicorns, belonging to four subfamilies, one Clerid, two Hispids, two Elaters, one Rhipidocerid, one Eucnemid, or seventeen Coleoptera in all, one moth and several Hemiptera. The Lycidæ, then, may be considered as distasteful insects which are characterized by a definite type of warning coloration, whilst the coloration of the insects which resemble them so closely can hardly be looked on as essentially typical of the groups to which the insects belong. The conspicuous Lycid, *Lycostomus gestroi* ♀, is mimicked by three Longicorns—*Erythrus apiculatus* var., *E. rotundicollis* and *sternalis*, and by *Eurycephalus lundi*, by a moth, *Phauda limbata*, by at least four bugs, of which *Ectatops rubiaceus* and *Serinetha abdominalis* alone have been identified.

The arrangement of colours in the Lycid *Metriorrhynchus kirschi*, in the Longicorns *Ephies dilaticornis* and *Erythrus biapicatus*, in the Hispid *Gonophora wallacei* var., and in a Clerid of the genus *Tenerus* (*T. sulcipennis* (Gahan)) is almost identical. *Calochromus dispar* is mimicked by the Longicorns *Pyrestes eximius* and *P. virgata*, by a Rhipidocerid of the genus *Ennomates*, and by an unidentified Eucnemid. The Lycids *Ditoneces* sp. near *fuscicornis* and *Taphes brevicollis*, the Lamiid Longicorn *Xyaste torrida*,

[1] A strong vitality is correlated with this distastefulness; I have seen a Lycid beetle walk away apparently uninjured after it had been well pecked by two or three fowls. The distasteful Endomychidæ are also difficult to kill (*cf.* also vitality of *Danainæ*, *Acræinæ*, and *Heliconinæ* noted by various authors).

and the Hispid *Gonophora wallacei* are much alike in their general appearance; and so too are the Lycids *Cautires excellens* and *Metriorrhynchus acutangulus*, the Elaters *Agonischius pectoralis* and *A.* (?) *sanguineipennis*, the Longicorns *Xyaste fumosa* and *X. invida*, and a Reduviid bug.

The association of these species in one convergent group is represented in a diagrammatic way in Table V. (p. 269): the species other than Lycidæ which I consider to be distasteful are indicated by an asterisk, but it is not improbable that others may hereafter be proved to be Müllerian rather than Batesian mimics.

[The prevalent types of Lycid coloration are very simple, being uniform red or ochreous or one of these colours combined with black. The same patterns have an immense range corresponding with the wide distribution of the family over the warmer parts of the world. Hence this beautiful group of Bornean insects of many orders which adopt a colouring characteristic of the Lycidæ could no doubt be paralleled in many countries. Examples of Lycoid American moths belonging to distasteful groups are given in Journ. Linn. Soc. (Zool.) vol. xxvi. p. 569. Mr. G. A. K. Marshall has sent me a wonderful group belonging to this type, the ground-colour being ochreous, from Salisbury, Rhodesia. The central type is provided by seven species of Lycidæ, and it is resembled by a Telephorid, a Melyrid, two Phytophaga, three Cantharidæ, three Longicorns, many species of Hymenoptera Aculeata, several Hemiptera, a fly (*Xiphocerus*), a Zygænid moth, and an Arctiid Moth. This group is briefly mentioned in the Report of the British Association (Section D), Bradford Meeting, 1900, p. 793.—E. B. P.]

A second group may be formed out of Coccinellid-like insects. All the well-known Coccinellidæ with red or yellow elytra spotted with black are the central figures of the group, with perhaps an excessively common Cassid, *Prioptera octopunctata*; mimicking these are a Longicorn, *Entelopes glauca* (Pasc.), two species of *Lema* and a *Curculio*, the remarkable new Locustid of a genus near *Gammarotettix*, a Pentatomid bug of the subfam. *Asopinæ*, *Blachia ducalis* (Wlk.), and a spider with large red abdomen spotted with black. The association is indicated diagrammatically in Table VI. (p. 270); the mimics of Coccinellidæ, which are believed to be Müllerian, are indicated by asterisks. Nearly the whole of the species here mentioned are figured on Plate XXIII. figs. 30 to 36. The *Lema* figured (*L. quadripunctata*) is a less perfect mimic than *L. femorata*.

The little Dammar-bee *Melipona vidua* (Lep.), black with white-tipped wings, is an extremely common insect in Borneo, and, though stingless, is protected by its ferocious biting and social habits[1].

[1] A certain tree in the jungle near the Sarawak Museum was known to harbour a nest of this species; when the bees swarmed it was impossible to approach the tree without attracting a large number which settled on one's hair and face and bit so fiercely that a hasty retreat had to be made. A tame monkey, secured by a chain and sliding ring to a bamboo pole which contained a nest of another species of *Melipona*, refused after two attempts to scale the pole when the bees were swarming round the mouth of the nest.

TABLE V.

Convergent Group 1.

(Lycoid pattern.)

HEMIPTERA.
Serinetha abdominalis * and *Ectatops rubiacens* * and others.

LEPIDOPTERA.
Phauda limbata. *

LYCIDÆ.

LYCOSTOMUS GESTROI.

COLEOPTERA.
Subfam. *Pyrestinæ.* *Erythrus rotundicollis.* *

Subfam. *Pyrestinæ.* *Erythrus apiculatus* * var.

Subfam. *Pyrestinæ.* *Erythrus sternalis.* *

Subfam. *Euryphaginæ.* *Eurycephalus lundi.* *

COLEOPTERA.
Fam. *Eucnemidæ.* Genus & sp. ?

COLEOPTERA.
Fam. *Rhipidoceridæ.* *Ennomates* sp.

CALOCHROMUS DISPAR.

Subfam. *Pyrestinæ.* *Pyrestes eximius* and *P. virgata.*

COLEOPTERA.
Fam. *Cleridæ.* *Tenerus sulcipennis.* *

COLEOPTERA.
Fam. *Hispidæ.* *Gonophora wallacei*, var. *

METRIORRHYNCHUS KIRSCHI.

Subfam. *Pyrestinæ.* *Erythrus biapicatus.* *

Subfam. *Lepturinæ.* *Ephies dilaticornis.*

HEMIPTERA.
Reduviid. *

CAUTIRES EXCELLENS and METRIORRHYNCHUS ACUTANGULUS.

COLEOPTERA.
Fam. *Elateridæ.* *Agonischius ? sanguineipennis.*

COLEOPTERA.
Fam. *Elateridæ.* *Agonischius pectoralis.*

Subfam. *Saperdinæ.* *Xyaste fumosa* and *X. invida.*

DITONECES sp. near FUSCICORNIS and TAPHES BREVICOLLIS.

COLEOPTERA.
Fam. *Hispidæ.* *Gonophora wallacei.* *

Subfam. *Saperdinæ.* *Xyaste torrida.*

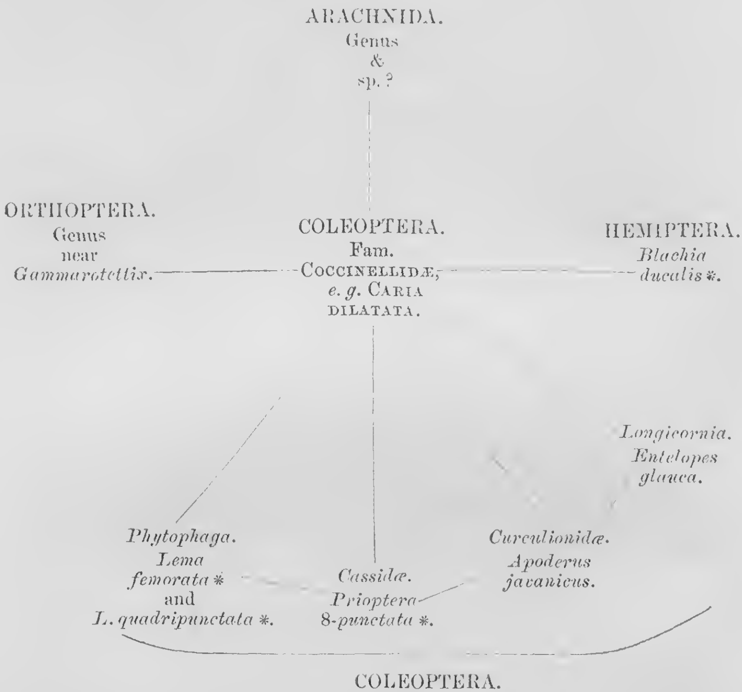
COLEOPTERA—LONGICORNIA.

The species mentioned in this table are figured, almost without exception, on Plate XXIII. figs. 1 to 29.

TABLE VI.

Convergent Group 2.

(Coccinellid pattern.)

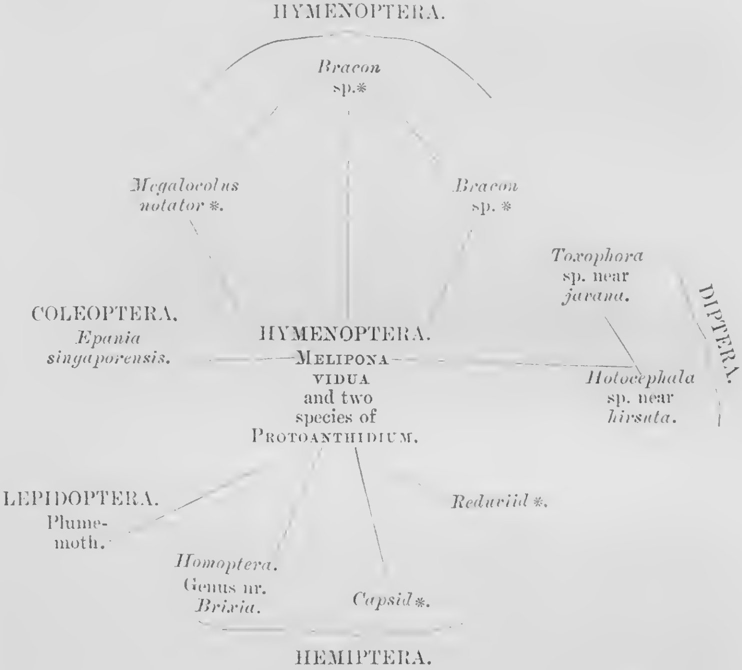


There are two species of *Protoanthidium* coloured in the same way; and there is a large concourse of insects of different orders mimicking this type of coloration, viz.: four Hymenoptera; three species of *Bracon*, one with very hairy hind femora and tibiæ simulating the dilated tibiæ of its model, and a Chalcid, *Megalocolus notator* (Walk.); a Longicorn, *Epania singaporensis* (Pasc.); a plume moth; a Capsid, a Reduviid, and an obscure Homopterous insect; two flies, *Holocephala* near *hirsuta* (v. d. Wulp), and *Toxophora* near *javana* (Wied.). The resemblances between these mimics and the *Melipona* are in some cases remarkably exact; the Longicorn and the *Holocephala* were taken in the company of the bees; all the mimicking Hymenoptera are indistinguishable from their model whilst on the wing. In this group I consider the *Melipona* to be the central typical warningly coloured and specially protected insect. Asterisks indicate the convergent species which are probably synaposematic in the following diagrammatic arrangement represented in Table VII. (p. 271). The whole of the species are shown in Plate XXIII. figs. 37 to 47.

Table VII.

Convergent Group 3.

(*Melipona*-like pattern.)



A fourth group is characterized by the following combination of colours: black head, red thorax, and iridescent green elytra. This type of coloration is well illustrated by a Melyrid, *Prionocerus cœruleipennis* (Perty), a Longicorn, *Erythrus viridipennis* (Gahan), an Erotylid, a Hispid, *Botryonopa cyanipennis* (Baly), and a Clerid. It is probable that the whole of these species are synaposematic, as is indicated in the accompanying Table VIII. Group 4 (p. 272). Four of the species are represented on Plate XXIII. figs. 58 to 61.

A fifth group has a broad red band across the middle of the abdomen; into this will fall two common wasps, *Vespa cincta* and *Polistes sagittarius*, and their mimics, a Sesiid moth, a fly, and a Mantispa. There is at present no reason for considering any of the convergent species shown in Table VIII. Group 5 as other than pseudaposematic. The *Mantispa* and *Polistes* are shown in figs. 27 & 26 on Plate XIX., the *Vespa* and *Milesia* on figs. 13 & 14 on Plate XXII.

TABLE VIII.

Convergent Group 4.

(Probably modified Lycoid pattern.)

Longicornia. *Erythrus viridipennis.* *

Fam. *Hispidæ.* *Botryonopa cyanipennis* *.

Fam. MELYRIDÆ. PRIONOCERUS CŒRULEIPENNIS.

Fam. *Cleridæ,* gen. et sp.? *

Fam. *Erotylidæ.* *Tetralanguria pyramidata.* *

Convergent Group 5.

(Red-girdled aculeate pattern.)

DIPTERA. *Milesia vespoides.*

LEPIDOPTERA. *Sesia* sp.

VESPA CINCTA. POLISTES SAGITTARIUS.

NEUROPTERA. *Mantispa* sp.

There is a considerable assemblage of uniformly-coloured ochreous species of Phytophaga of the families Halticidæ, Galerucidæ, etc., and of mimicking Longicorns of the subfamilies *Saperdinæ* and *Astatheinæ*; these, however, are not included in the table, as sufficient examples have been given clearly to illustrate the wide distribution of a characteristic type of warning coloration.

APPENDIX I.

1. LEPIDOPTERA RHOPALOCERA, by R. SHELFORD.

ELYMNIAS AROA, sp. n.

♂. Dark fuscous brown, with the following cream-white markings:—*Upper side*: *fore wing*, a submarginal series of spots commencing from below the discoidal nervule, the last one double; some indistinct notching at the external angle; the external margin is somewhat irregularly scalloped: *hind wing*, a sub-discal series of internervular spots and dashes, one of each to each interspace, the last interspace but one carrying a double

set, the last a single streak; a series of large submarginal spots, the last of which fuses with the above-mentioned streak, the others partially or completely distinct; some marginal irregular mottlings. Wing rather deeply scalloped and subcaudate. *Under side* pale fuscous; *fore wing*, costal area black barred with white, some basal white mottlings, submarginal spots more distinct than on the upper side; *hind wing*, some basal white spots, one below the first subcostal nervule, another just below the cell, the subdiscal series very indistinct, the submarginal series of large spots distinct, a marginal mottled band of transverse streaks far more pronounced than on the upper side, inner margin blackish barred with white. Cilia white and fuscous alternately. Expanse 80 mm.

♀. *Upper side* paler fuscous, markings as in the male; *under side* as in the male but the markings more diffuse. Expanse 93 mm.

Hab. Mt. Penrissen, Sarawak.

Types in the Sarawak Museum.

The nearest ally of the species appears to be *E. lutescens* (Butl.).

2. Coleoptera Longicornia, by C. J. Gahan.

Zelota, gen. nov. (*Mesosinarum*).

Head deeply concave between the divergent antenniferous tubers; front slightly convex, narrowed between the eyes; genæ long and somewhat swollen; eyes divided, rather finely facetted. Antennæ of the male scarcely longer than the body; scape stout, subclavate, furnished at its apex with a short spine behind and a narrow cicatrix in front, the latter completely bounded by a projecting rim; third joint slender, slightly curved, nearly twice as long as the first or fourth, armed at the apex with a sharp spine; 5th to 11th joints very short, together scarcely longer than the 4th; last five or six joints thickly fringed with long hairs underneath, the remaining joints being sparsely ciliate. Prothorax transverse, rounded and unarmed at the sides. Mesonotum without stridulating area, arcuately emarginate in front. Elytra but little longer than their conjoined width, prominent at the shoulders, broadly rounded at the apex; each furnished a little behind the base with a very prominent ridge, surmounted by a tuft of long hairs tapering to a point in imitation of a spine. Prosternum strongly arched, almost vertically sloped behind. Mesosternum short and horizontal behind, subvertical in front. Legs subequal in length; femora fusiform; middle tibiæ without notch on outer margin; claws of tarsi divergent.

This new genus comes near *Cacia* (Pasc.) in the group or subfamily *Mesosinæ*; and in the same section with it should be placed the genera *Planodes* (Newm.) and *Calymmophis* (Thoms.), which Lacordaire, on insufficient grounds, withdrew from the *Mesosinæ*, assigning them a place in his "groupe" *Monohammides*. The genus *Ereis* (Pasc.), which was treated by him in the same way, should also be restored to the *Mesosinæ*, finding a place near the genus *Mesosa*.

ZELOTA SPATHOMELINA, sp. n. (Plate XXIII. fig. 57.)

Nigro-cyanea; capite fere nigro, in fronte subnitido, utrinque pone oculum inferiorem macula rufo-fulvescente notato; prothorace transverso, lateraliter rotundato, antice transversim sulcato, tenuissime griseo-pubescente; elytris sat dense punctulatis, nigro-cyaneis aut violaceis, utrisque maculis duabus aut tribus rufo-fulvis notatis—una communi paullo pone scutellum, secunda ad marginem externam paullo pone basin, tertia fere ad medium disci; pedibus nigro-cyaneis aut violaceis, sparse ciliatis; tibiis extus in medio albo-cinereis.

Long. 7–8; *lat.* 3½–4 *mm.*

Hab. Sarawak. 1 ♂ in Brit. Mus., 2 ♂ ♂ from Kuching, Sarawak (*R. Shelford*), in the Hope Museum, Oxford.

In the two ♂ specimens in the Hope Museum there is a small spot of reddish pubescence just under the anterior part of the lower lobe of each eye, in addition to the somewhat larger rounded spot of the same kind behind the lobe. In these specimens also the third reddish spot of each elytron—that placed a short distance behind the base of the large tufted tubercle, but a little more externally—is present and distinct, and there is a cinereous patch crossing the elytra a little in front of the apex.

APPENDIX II.

Descriptions of additional Species mentioned and figured in the accompanying paper.

[Received January 5, 1903.]

1. LEPIDOPTERA HETEROCERA, by KARL JORDAN.

MIMEUPLŒA TRISTIS, sp. n. (Plate XXI. fig. 12, ♀.)

♂. Body olive-black, with a rather feeble greenish-blue gloss; under side white-spotted as in *M. rhadamantha.* Wings mummy-brown above and below, not distinctly metallic, except costal margin of fore wing below and a small dot at base of fore wing above. Fore wing, upper side: a series of broad creamy-white streaks from costal margin to SM^2, separated by the brown veins, the upper ones reaching from margin halfway to cell, the posterior ones shorter and not quite touching margin. A series of streaks also on hind wing, but here thin, submarginal. The streaks present on under side of both wings, broader than above, all reaching margin.

♀. Similar to ♂; streaks of fore wing vestigial and narrow above, the five posterior ones ending proximally in a small white spot, streak M^1–M^2 much longer than the two above and the one below it; streaks of under side of fore wing broader than above, but thinner than in male and much more clayish. No streaks on hind wing above, but vestiges of them present on underside. (Neuration of this specimen abnormal on right fore wing.)

Length of fore wing: ♂ 32, ♀ 36 mm.

Hab. North Borneo: ♂ from Sandakan, June 28, 1894 (D. Cator, in the Tring Museum); ♀ from Kuching, Oct. 1895 (Sarawak Museum, Kuching).

Neuration similar to that of *M. rhadamantha.*

2. COLEOPTERA LONGICORNIA, by C. J. GAHAN.

ERYTHRUS ROTUNDICOLLIS, sp. n. (Plate XXIII. fig. 6, ♂.)

*Niger, elytris a basi usque paullo pone medium rufis: antennis quam corpore a quarta parte brevioribus, articulis 5° ad 10*um* ad apicem antice dentatis; prothorace lateraliter rotundato, latitudine maximo ad medium, disco tuberculis duobus parvis nigro-pilosis vix ante medium positis instructo; elytris postice rotundatim attenuatis, utrisque ad suturam breviter dentatis.*

Long. 17; *lat.* 4 *mm.*

Hab. Mt. Santubong, 2600 ft., February 4, 1900. One male specimen.

Black, with rather more than the basal half of the elytra red. Antennæ about three-fourths the length of the body, with the joints from the fifth to the tenth produced into a tooth at the antero-distal angle. Prothorax rather strongly rounded at the sides and widest about the middle; the disk with two small velvety tubercles placed barely in front of the middle. Elytra slightly widening from the base up to about the posterior third or fourth, and thence narrowing towards the apex, where each ends in a small sutural spine; the disk of each with a rather feeble costa extending from the base to a little beyond the middle.

This species most resembles *E. atricollis* Pasc., but in the latter the dark apical area of the elytra is less extensive; the prothorax is less rounded, is widest behind the middle, and on the disk has but a single median cariniform tubercle.

ERYTHRUS STERNALIS, sp. n. (Plate XXIII. fig. 7, ♂.)

Niger, elytris a basi usque pone medium rufis: prothoracis disco tuberculo mediano inter medium basinque, et utrinque tuberculo parvo paullo ante basin posito, instructo; elytris postice rotundatim attenuatis, utrisque ad suturam sat valde spinosis; prosterno inter coxas tuberculato, mesosterno postice minus fortiter tuberculato.

Long. 20; *lat.* $4\frac{1}{2}$ *mm.*

Hab. Mt. Matang, 3600 ft., June 1900. Two male specimens; in British Museum and Hope Collection, Oxford.

Black, with basal three-fifths of the elytra red. Antennæ about three-fourths the length of the body; fifth joint angulate, each of the succeeding joints up to the tenth strongly toothed in front at the apex. Prothorax strongly and thickly punctured, with a median cariniform tubercle between the middle and the base, and a small blunt tubercle on each side of the disk nearer to the base. Elytra rather strongly punctured; the disk of each with a well-marked costa reaching from the base to within about

one-fifth from the apex. Prosternum rather strongly tuberculate between the coxæ; the mesosternum with a smaller tubercle on its hinder half.

This is the only species of the genus known to me in which the sternal processes are distinctly tuberculate.

ERYTHRUS BIAPICATUS, sp. n. (Plate XXIII. fig. 19, ♀.)

Niger, prothoracis disco et elytrorum basi rufis, nigro-vittatis: prothorace ruguloso-punctato, sine tuberculis distinctis; elytris dense granulatis, postice divaricatis, utrisque in spinam parvam terminantibus.

Long. $15\frac{1}{2}$; *lat.* $3\frac{1}{2}$ *mm.*

Hab. Kuching, Mt. Matang, 3600 ft., June 1900. One female example.

Black, with the disk of the prothorax and the basal third of the elytra partly red, the red of the prothorax being interrupted by two black bands extending from the front margin, and by a small median spot near the base, while the red on the base of the elytra is divided by a narrow band along the suture, and two wider bands on each side extending forwards and gradually narrowing from the posterior black area. Prothorax rugulose punctate, and showing traces only of the tubercles present in most of the other species. Elytra very densely granulate, the granules bearing very minute black setæ, which are scarcely evident except on the rufous areas near the base. Metasternum somewhat similarly granulate to the elytra, and the abdomen much more finely so. Antennæ of the female about half the length of the body, with the joints from the fifth to the tenth rather broad, and angulate at the apex on the anterior side.

The divergence of the elytra from the suture behind and the granulation of their surface serve to distinguish this species from all those hitherto described belonging to the genus.

ERYTHRUS VIRIDIPENNIS, sp. n. (Plate XXIII. fig. 58.)

*Niger, prothorace toto rufo, elytris viridescentibus aut viridi-cyaneis et opacis; antennis (♂) quam corpore paullo brevioribus, (♀) medium elytrorum vix superantibus, articulis 5° ad 10*um* modice dilatatis ad apicem dentatis; prothorace obsolete punctato, supra leviter quadri-nodoso; elytris creberrime ruguloso-punctatis, apice subsinuatis ad suturam breviter spinosis.*

Long. 12–16; *lat.* $2\frac{1}{2}$–3 *mm.*

Hab. Mount Matang, near Kuching in Sarawak (3600 ft. alt.), June 1900. Five examples; in the British Museum and Hope Collection, Oxford.

Prothorax red above and below, elytra of a dull green or bluish-green colour, all the rest of the body together with the legs and antennæ being black. Prothorax indistinctly punctured, furnished with four feeble nodules on the disk, two being near the middle and two, more widely separated from each other, near

the base. Elytra very closely rugulose-punctate, gradually widening from the base backwards, broadly rounded and slightly sinuate at the apex, with a short spine on each at the suture.

NOTHOPEUS INTERMEDIUS, sp. n. (Plate XIX. fig. 21, ♂.)

Corpore supra, capite toto, pedibus antennisque fulvis, his versus apicem infuscatis; thorace subtus et abdomine nigro-cyaneis, sed prosterno mesosternoque medio, maculis duabus metasterni et segmento primo abdominis fulvis, hoc argenteo-sericeo; elytris (quod attinet ad hoc genus) perelongatis, apicem abdominis fere attingentibus.

Long. 27; *lat. (pone humeros)* 7 *mm.*

Hab. Sarawak, Mt. Penrissen, May 1899. One male example; in the Sarawak Museum, Kuching.

Head, antennæ (except the last four joints, which are brownish), disk of prothorax, and elytra tawny red; body underneath bluish black, but with the prosternum, mesosternum, a spot on each side of the metasternum, and the whole of the first abdominal segment tawny, the latter being covered with a silky pubescence giving silvery reflexions in certain lights. The elytra, though unusually long for this genus, extending nearly to the apex of the abdomen, are considerably narrowed from a little behind the shoulders, and each in its posterior half is scarcely half as broad as it is at the base. The hind tibiæ of the male are thickened and subcylindrical, narrowed towards the base and very slightly also towards the distal end.

This species comes nearest in structural characters to *Aphrodisium tibiale* Rits., from Assam, but differs from it in having the elytra still more attenuated behind and the front of the head narrower. Ritsema placed his species in *Aphrodisium* as an aberrant member of that genus; but considering the reduction in the size of the elytra and the peculiar form of the male hind tibiæ, I believe it to be better placed in *Nothopeus*, though undoubtedly showing strong affinities with *Aphrodisium*. His species and the one here described are both extremely interesting as showing the gradual progress of that modification leading to the very shortened elytra and the strongly mimetic forms characteristic of the genus *Nothopeus*.

PSEBENA, gen. nov.

Head short, as broad as the prothorax; eyes finely facetted, deeply emarginate, with the lower lobes rounded, the upper very narrow; palpi short and slender. Antennæ (♀) a little longer than the body, slender, filiform; 3rd, 4th, and 5th joints subequal to one another, each twice as long as the 1st; 6th distinctly shorter than the 5th; the succeeding joints gradually diminishing in length. Prothorax subcylindrical, as broad as it is long. Elytra short, squamiform, not reaching beyond the apex of the first abdominal sternite. Prosternum narrowed behind; front coxæ prominent, their acetabula angulate outwards and

open behind. Mesosternum much broader than the prosternum; acetabula of middle coxæ open to the epimera. Metathoracic episterna rather broad in front, narrowed behind. Femora pedunculate at base, gradually thickened into a fusiform club towards the distal end. Hind legs much longer than either of the anterior pairs; first joint of hind tarsi longer than the three succeeding joints together. Abdomen normal, its intercoxal process rather broad, and obtuse in front.

This genus, which I was at first inclined to refer to Lacordaire's group *Psebiinæ*, seems to me, on fuller consideration of its characters, to be better placed in the *Necydalinæ*, although it differs from other members of this group in having no anterior prolongation of the head, the front from the interantennary ridge to the clypeal suture being relatively very short, and the clypeus scarcely broader than the labium. The *Psebiinæ* have certain characters, wanting to the present genus, which point to an affinity with the *Auxesinæ* and *Methiinæ*, and, through those groups, with the *Œminæ*.

PSEBENA BREVIPENNIS, sp. n. (Plate XIX. fig. 12, ♀.)

Capite, prothorace, elytris ad basin, articulo primo antennarum et pedibus quatuor anterioribus rufo-testaceis; metasterno medio testaceo, lateraliter fusco; abdomine medio et pedunculis femorum posticorum pallide testaceis; ceteris nigro-fuscis aut nigris.

Long. 13–16 *mm.*

Hab. Kuching in Sarawak, Sept. 29 and Dec. 4, 1899. Two female examples; in British Museum and Hope Collection, Oxford.

Head, prothorax, first joint of the antennæ, the four anterior legs, and the base of the elytra testaceous red. Metasternum testaceous in the middle, dark brown at the sides. Abdomen pale testaceous along the ventral surface from the base to the last segment, this segment and the lateral borders being, like the upper side, brownish black. Hind legs also black, with the femoral stalks pale testaceous or nearly white. The head and prothorax are covered with a very faint reddish pubescence, but the prothorax has two slightly raised areas on each side bare of pubescence. The inner portion of each elytron near the base is very closely punctulate and covered with a faint pubescence, the outer and apical parts being sparsely punctulate and more glossy.

3. COLEOPTERA: *Cleridæ*, by the Rev. H. S. GORHAM and C. J. GAHAN.

CALLIMERUS CATENATUS (Gorham). (Plate XXIII. fig. 54.)

Nigro-subcæruleus, squamis albis ornatus; capite creberrime subtiliter, prothorace elytrisque parce distincte punctatis; prothorace nitido, oblongo, lateribus parum ampliatis, utrinque uni-impressis, cum marginibus anticis et posticis albo-squamosis; elytris opacis, apicibus oblique truncatis, lunulis

duabus in singulo, externe apertis, albis ; pectore albo ; ore, antennis, palpis pedibusque testaceis.

Long. 9 *mm.*

Mas? *Tibiis posticis juxta apicem denticulo acuto externe munitis.*

Hab. N.W. Borneo, Kuching.

Allied to and somewhat resembling *C. mirabilis* Gorh. Narrow, elongate, and rather smaller than the unique type of that species; clothed (including the legs) with very fine hairs. The white markings are (as in other species of this genus) composed of snow-white scales. The pattern is different from that of *C. mirabilis* in that there are on each elytron but two white lunules unconnected; each pair form an oblong X, but are scarcely joined at the suture. The apex is truncate, as in *C. mirabilis.*

A single example, apparently a male, collected Oct. 6, 1899.

TENERUS SULCIPENNIS (Gahan).

Niger; prothorace lateraliter nigro-viridescente, dimidio basali elytrorum et plaga sub-semicirculare ad basin pronoti pube rufo-velutina obtectis, dimidio apicali elytrorum atro-pubescente. Antennis articulis 3° ad 10^{um} antice valde dilatatis, articulo 3° quam 4° paullo angustiore; pronoto ad medium basis paullo gibboso; elytris utrisque quadri-sulcatis, interstitiis sat latis, leviter convexis.

Long. 11 ; *lat.* $2\frac{3}{4}$ *mm.*

Hab. Kuching (March 1900). Two examples; in British Museum and Hope Collection, Oxford.

This species seems nearest allied to *T. cingalensis* White and *T. parryanus* Gorh., but differs from these and from all other known species of the genus in having the third joint of the antennæ almost as strongly dilated as the fourth, and the elytra impressed with longitudinal grooves.

4. COLEOPTERA: RHYNCHOPHORA, *Brenthidæ*, by Dr. A. SENNA.

DIURUS SHELFORDI Senna. (Plate XX. fig. 6, ♀.)

Moderately elongate, stoutish, black, provided with whitish scales of differing size sunk in the punctures; the head and the metarostrum with punctiform close-set scales, the joints of the antennæ clothed with long accumbent scales.

♂. Head slightly longer than broad, with the sides almost straight and a fovea between the eyes, which are prominent; the metarostrum is twice as long as the head and hardly narrowed before the antennæ; the prorostrum is short, naked, dark reddish brown. The antennæ are inserted near the apex of the rostrum: the 3rd joint is longer than the 4th, the 4th a little longer than the 5th, the 7th and 8th subequal; the three apical joints are distinct, slightly thickened and finely pubescent.

The prothorax is similarly shaped as in *D. furcillatus* (Gylh.), but comparatively broader; its upper surface is covered with

large irregular punctures, and marked on each side with a longitudinal line of rounded white scales, and in the middle with a line of small scales; moreover, punctiform scales are sunk in the punctures.

The elytra are slightly broader at the base than the prothorax in the middle, the sides are parallel, the apex is normally narrowed; they have above three narrow longitudinal costæ, the interstices between which are punctate and provided with rounded scales; the sides are foveate, each fovea shows a setiform scale; moreover, a line of rounded scales is present along the lateral margin; the outer angles of the elytra at the apex are simply toothed.

The metasternum and the base of the abdomen are covered with rounded scales; the rostrum beneath and the legs are scattered with scale-like setæ. The 3rd abdominal segment is short and contracted in the middle.

♀. Agrees with the male in all respects except the following:—The body is broader; the head short, nearly square; the metarostrum is shorter, as long as the head; the prorostrum much more elongate, longer than the metarostrum; the antennæ are inserted between the middle of the rostrum and its base; they are comparatively shorter and stouter; the 3rd abdominal segment is longer and not contracted.

Length 17–23 mm.

Hab. Kuching (N.W. Borneo).

Allied to *D. furcillatus* (Gylh.), but the new species has the head shorter and the eyes more prominent; the prorostrum is shorter; the joints of the antennæ are longer, the three apical ones more distinct; the apex of the elytra are broader and slightly toothed; the body is shorter and stouter. The female of the new species is, moreover, distinguished by the metarostrum which is shorter, and by the antennæ which are inserted before the middle of the rostrum.

I have named this species in honour of Mr. R. Shelford, who has kindly presented an interesting collection of Bornean Brenthids to the Oxford University Museum.

Diurus silvanus Senna. (Plate XX. fig. 4, ♀.)

The female of this species being hitherto undescribed, I give a short description of it:—

The head is nearly square, with a fovea between the eyes; the metarostrum is short, hardly so long as the head, channelled above, and slightly narrowed before the antennæ; the prorostrum is slender, glossy, finely punctured, as long as the head and metarostrum taken together. The antennæ, which are consequently more approximate to the base than to the apex of the rostrum, are rather stout, with the 3rd joint longer than the 4th, the 6th and 7th subequal, the 8th a little shorter, the three apical joints well distinct and separate. The prothorax is strongly contracted anteriorly, the sides towards the middle are almost

parallel. The elytra are longer than twice the prothorax, narrowed at and sloping rapidly to the apex; the tails are more approximate than those of *D. furcillatus* (Gylh.); moreover, they are short and almost straight.

This species, by the shape of the elytra at the apex, is allied to *D. erythropus* (Rits.), but easily distinguished by the longer prorostrum, by the insertion of the antennæ being more approximate to the base of the rostrum, and by the three apical joints being well distinct and separated.

Length 30 mm. (the tails excluded).

Hab. Matang (Borneo).

EXPLANATION OF THE PLATES.

Plate XIX.

Figures 16 to 19 are about twice the natural size: the remainder about $\frac{6}{7}$ of the natural size.

Fig. 1. *Tricondyla cyanea* (Lep.), var. *wallacei* (Thoms.).	Kuching, Feb. 1899.
2. *Condylodera tricondyloides* (Westw.), mature individual.	Kuching, March 2, 1900.
3. *Tricondyla gibba* (Chaud.).	Matang, Aug. 1899.
4. *Condylodera tricondyloides* (Westw.), immature individual.	Kuching, Dec. 12, 1899.
5. *Collyris sarawakensis* (Thoms.).	Kuching, May 14, 1900.
6. *Condylodera tricondyloides* (Westw.), very young individual.	Kuching, July 18, 1900.
7. *Pheropsophus agnatus* (Chaud.).	Kuching, Aug. 20, 1897.
8. *Gryllaeris*, n. sp. vicinissima *nigratæ* (Br.).	Sarawak.
9. *Alcides* sp.	Kuching, April 20, 1900.
10. *Issus bruehoides* (Walk.).	Kuching, Sept. 14, 1899.
11. *Sclethrus amœnus* (Gory).	Kuching, May 14, 1900.
12. *Psebena brevipennis* (Gahan).	Kuching, Dec. 4, 1899.
13. *Oberea strigosa* (Pasc.), var., from left side.	Kuching, July 26, 1899.
14. *Oberea brevicollis* (Pasc.), from left side.	Kuching, March 15, 1899.
15. *Oberea*, probably n. sp. near *strigosa* (Pasc.), from left side.	Matang, March 14, 1898.
16. Larva of *Eulyes amœna* (Fab.), from right side.	Kuching, probably 1899.
17. Larva of *Hymenopus bieornis* (Stoll), from right side.	Kuching, probably 1899.
18. Larva of *Eulyes amœna* (Fab.), dorsal view.	Kuching, probably 1899.
19. Larva of *Hymenopus bicornis*, dorsal view.	Kuching, probably 1899.
20. *Salius aurosericeus* (Guér.).	Kuching, July 3, 1899.
21. *Nothopeus intermedius* (Gahan), ♂.	Penrissen, May 1899.
22. *Braeon* sp.	Matang, Aug. 1899.
23. *Mantispa simulatrix* (McLachl.).	Matang, Aug. 1899.
24. *Polistes* sp. near *diabolieus* (Sauss.).	Kuching, July 27, 1899.
25. *Mantispa* sp.	Kuching, July 12, 1900.
26. *Polistes sagittarius* (Sauss.).	Kuching, July 2, 1898.
27. *Mantispa* sp.	Matang, 3600 ft., June 1900.

Plate XX.

Figures 4 *a*, 7 *a*, 8 *a*, and 10 *a* are about 4 times the natural size: the remainder about $\frac{9}{10}$ of the natural size.

Fig. 1. *Baryrhynchus dehiscens* (Sch.), ♂.	Matang, Aug. 1899.
2. *Baryrhynchus dehiscens* (Sch.), ♀.	Kuching, 1899.
3. *Alibora* sp.	Kuching, Aug. 10, 1899.
4. *Diurus silvanus* (Senna), ♀.	Matang, Aug. 1899.
4 *a*. Left elytron of above. Dorsal view of apex, × 4.	
5. *Diurus forcipatus* (Westw.), ♂.	Kuching, Sept. 14, 1899.
6. *Diurus shelfordi* (Senna), ♀.	Kuching, Nov. 2, 1899.

Fig. 7. *Ægoprepis insignis* (Pasc.). — Matang, Aug. 1899.
7 *a*. Left elytron of above. Dorsal view of apex, × 4.
8. *Stegenus dactylon* (Pasc.). — Kuching, Oct. 31, 1900.
8 *a*. Left elytron of above. Dorsal view of apex, × 4.
9. *Dymascus porosus* (Pasc.). — Kuching, July 9, 1900.
10. *Ectatosia moorei* (Pasc.). — Kuching, April 3, 1900.
10 *a*. Left elytron of above. Dorsal view of apex, × 4.
11. *Ænidia* sp. — Kuching, Feb. 1899.
12. *Serixia prolata* (Pasc.). — Kuching, Sept. 20, 1899.
13. *Metrioidea apicalis* (Jac.), var. — Kuching, Aug. 1, 1899.
14. *Entelopes*, n. sp. near *wallacei* (Pasc.). — Sarawak.
15. *Aulacophora luteicornis* (Fab.), var. — Sarawak.
16. *Tropimetopa simulator* (Pasc.). — Kuching, Aug. 4, 1897.
17. *Ochralea nigripes* (Oliv.), var. — Kuching, March 28, 1900.
18. *Astathes unicolor* (Pasc.) = *coccinea* (Pasc.). — Kuching, Aug. 17, 1898.
19. *Caritheca mouhoti* (Baly). — Kuching, Aug. 8, 1899.
20. *Astathes splendida* (Fab.). — Kuching, Aug. 1899.
21. *Antipha ? nigra* (Alld.), var. — Kuching, Aug. 11, 1899.
22. *Astathes posticalis* (Thoms.). — Kuching, Aug. 15, 1899.
23. *Haplosonyx albicornis* (Wied.). — Brit. N. Borneo, Sandakan, about 1895–6. A. L. Cook.
24. *Astathes caloptera* (Pasc.) = *cyanipennis* (Thoms.). — Brit. N. Borneo, Sandakan, about 1895–6. A. L. Cook.
25. *Aulacophora boisduvali* (Baly). — Kuching, Sept. 13, 1899.
26. *Entelopes amœna* (Pasc.). — Matang, Dec. 1898.
27. *Ænidia* sp. near *læta* (Baly). — Penrissen, May 1899.
28. *Chreonoma*, ? n. sp. — Penrissen, May 1899.
29. *Xylotrechus pedestris* (Pasc.). — Kuching, March 28, 1900.
30. *Cylindrepomus peregrinus* (Pasc.). — Kuching, March 28, 1900.
31. *Chlorophorus annularis* (Pasc.). — Pankalan Ampat, 5–6000 ft., base of Penrissen, May 1899
32. *Cylindrepomus comis* (Pasc.). — Kuching, March 29, 1900.
33. *Cylindrepomus* ? form of *comis* (Pasc.). — Matang, Aug. 1899.
34. *Daphisia* sp. ♀. — Matang, 3600 ft., June 1900.
35. *Demonax viverra* (Pasc.). — Penrissen, 4500 ft., May 17, 1899.
36. *Daphisia* sp. — Kuching, Aug. 4, 1897.
37. *Clytanthus sumatrensis* (Lap. & Gor.). — Trusan.
38. *Cryllis clytoides* (Pasc.). — Kuching, July 17, 1899.
39. *Demonax mustela* (Pasc.). — Pankalan Ampat, 5–6000 ft., base of Penrissen, May 1899.
40. *Leptura* sp. — Penrissen, May 1899.
41. *Xylotrechus decoratus* (Pasc.). — Penrissen, May 1899.
42. *Leptura* sp. near *histrionica* (Pasc.). — Penrissen, 4200–4500 ft., May 1899.
43. *Chloridolum cinnyris* (Pasc.). — Penrissen, May 1899.
44. *Leptura*, ? n. sp. — Matang, Aug. 1899.
45. *Chloridolum* sp. near *thomsoni* (Pasc.). — Penrissen, May 1899.
46. *Chloridolum thomsoni* (Pasc.). — Kuching, July 20, 1900.
47. *Saperdides*, ? gen. ? sp. — Matang, March 13, 1898.
48. *Xystrocera alcyonea* (Pasc.). — Kuching, Sept. 7, 1897.

Plate XXI.

The figures are rather over $\frac{2}{3}$ of the natural size.

Fig. 1. *Delias pandemia* (Wallace), ♂. — Borneo.
2. *Isbarta pandemia* (Rothsch.). — Kina Balu Mt., Borneo, about 1896.
3. *Delias aglaia* (Linn.), ♀. — Brit. N. Borneo. Pryer, 1878–98.
4. *Isbarta dissimulata* (Walk.). — Sarawak. Wallace.
5. *Delias cathara* (Grose-Smith). — Penrissen, 3500 ft., May 19, 1899.
6. *Callamesia* (*Cyclosia*) *pieridoides* (Walk.). — Penrissen, 3500 ft., May 19, 1899.
7. *Scrobigera hesperoides* (Walk.). — Limbang River, N. of Sarawak, April 1895. E. Bartlett.

Fig. 8. *Eterusia obliquiaria* (Walk.).	Saribas, 100 miles N.E. Kuching, Nov. 1900.
9. *Danisepa lowei* (Butl.).	Brit. N. Borneo, Sandakan, about 1895–6. A. L. Cook.
10. *Mimeuplœa rhadamantha* (Butl.), ♂.	Kuching, Nov. 1895.
11. *Penoa menetriesii* (Feld.).	Borneo.
12. *Mimeuplœa tristis* (Jordan), ♀.	Kuching, Oct. 1895.
13. *Trepsichrois mulciber* (Cram.).	Brit. N. Borneo, Sandakan, about 1895–6. A. L. Cook.
14. *Pompelon marginata* (Guér.).	Sarawak. Wallace.

Plate XXII.

Figures 1 and 2 are about $\frac{3}{4}$ of the natural size: the remainder about $\frac{6}{7}$ of the natural size.

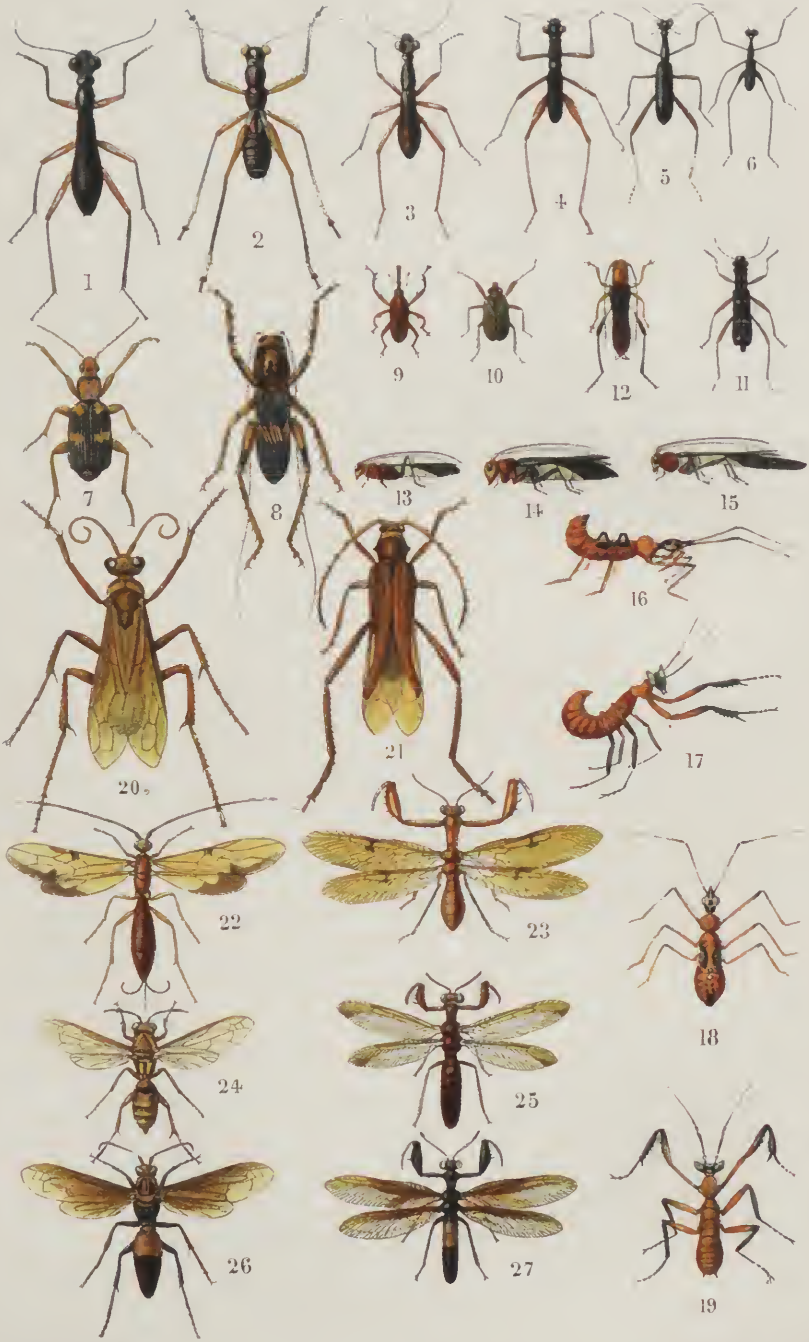
Fig. 1. *Xylocopa latipes* (Drury).	Matang, March 1898.
2. *Hyperechia fera* (v. d. Wulp).	Kuching, Feb. 1899.
3. *Collyris emarginata* (Macl.).	Mt. Serambu, Dec. 1898.
4. *Sepedon* sp. near *javanicus* (Desv.).	Mt. Serambu, Dec. 1898.
5. *Mesostenus* sp. near *pictus* (Smith).	Penrissen, May 1899.
6. Gen. et sp. ? Fam. Stratiomyidæ, Subfam. *Raphioccrinæ*.	Penrissen, May 1899.
7. *Mesostenus* sp.	Pankalan Ampat, 5–6000 ft., base of Penrissen, May 1899.
8. ? *Xylophagus* sp.	Penrissen, May 1899.
9. *Salius sericosoma* (Smith).	Kuching, Feb. 2, 1898.
10. *Laphria* sp. near *terminalis* (v. d. Wulp).	Kuching, July 29, 1899.
11. *Macromeris violacea* (Lep.).	Matang, March 13, 1898.
12. *Midas* n. sp.	Mt. Santubong, Aug. 1900.
13. *Vespa cincta* (Fab.).	Matang, 3600 ft., June 1898.
14. *Milesia vespoides* (Walk.).	Kuching, April 3, 1900.

Plate XXIII.

The figures are slightly reduced.

Fig. 1. *Ectatops rubiaceus* (A. & S.).	Matang, Dec. 1897.
2. *Serinetha abdominalis* (Fab.).	Botanic Gardens, Singapore, Jan. 1899.
3. *Phauda limbata* (Wllgrn.).	Botanic Gardens, Singapore, Jan. 1899.
4. *Lycostomus gestroi* (Bourg.), ♀.	Kuching, July 12, 1899.
5. *Lycostomus gestroi* (Bourg.), ♂.	Mt. Santubong, 2600 ft., Feb. 4, 1900.
6. *Erythrus rotundicollis* (Gahan), ♂.	Mt. Santubong, 2600 ft., Feb. 4, 1900.
7. *Erythrus sternalis* (Gahan), ♂.	Matang, 3600 ft., June 1900.
8. *Erythrus apiculatus* (Pasc.), var.	Matang, Aug. 1899.
9. Rhipidoceridæ, ? gen. *Ennomates*.	Matang, Dec. 1898.
10. Eucnemidæ, ? gen. ? sp.	Kuching, July 2, 1900.
11. *Calochromus* (*Micronychus*) *dispar* (C. Waterh.), ♀.	Matang, Aug. 1899.
12. *Pyresthes virgata* (Pasc.).	Matang, 3600 feet, June 1900.
13. *Eurycephalus lundi* (Fab.).	Kuching, May 7, 1900.
14. *Tenerus sulcipennis* (Gahan).	Kuching, March 14, 1900.
15. *Gonophora wallacei* (Baly), var.	Kuching, May 28, 1900.
16. *Metriorrhynchus kirschi* (C. Waterh.), ♂.	Kuching, Aug. 15, 1899.
17. " " (C. Waterh.), ♂.	Kuching, May 28, 1900.
18. *Ephies dilaticornis* (Pasc.), var. ♂.	Matang, 3600 ft., June 1900.
19. *Erythrus biapicatus* (Gahan), ♀.	Matang, 3600 ft., June 1900.
20. *Agonischius* ? *sanguineipennis* (Cand.).	Kuching, May 16, 1900.
21. *Agonischius pectoralis* (Cand.).	Kuching, May 16, 1900.
22. Reduviid sp.	Sarawak.
23. *Melampyrus acutangulus* (Bourg.), ♂.	Matang, Aug. 1899.
24. *Cautires excellens* (C. Waterh.), ♀.	Kuching, Sept. 6, 1899.

Fig. 25. *Xyaste fumosa* (Pasc.).	Kuching, March 23, 1900.
26. *Xyaste invida* (Pasc.).	Kuching, July 10, 1899.
27. *Gonophora wallacei* (Baly).	Kuching, Aug. 1897.
28. *Taphes brevicollis* (C. Waterh.), ♀.	Kuching, Jan. 24, 1900.
29. *Ditoneces* sp. near *fuscicornis* (Gorh.).	Kuching, Sept. 6, 1899.
30. *Caria dilatata* (Fab.).	Matang, March 13, 1898.
31. *Prioptera octopunctata* (Fab.).	Sarawak.
32. *Entelopes glauca* (Guér.).	Penrissen, May 1899.
33. *Blachia ducalis* (Walk.).	Kuching, Dec. 13, 1900.
34. Locustid of new genus near *Gammarotettix*.	Kuching, Feb. 2, 1901.
35. *Lema quadripunctata* (Oliv.).	Kuching, Oct. 12, 1899.
36. *Apoderus javanicus* (Jekel).	Kuching, April 4, 1900.
37. Pterophorid, probably near genus *Coremaguia*.	Kuching, Jan. 16, 1901.
38. *Bracon* sp.	Kuching, April 24, 1900.
39. Homopteron of genus probably near *Brixia*.	Kuching, Jan. 17, 1901.
40. *Epania singaporensis* (Thoms.).	Penrissen, May 1899.
41. *Melipona vidua* (Lepel.).	Kuching, May 8, 1900.
42. Capsid sp.	Kuching, June 22, 1900.
43. *Holocephala ? hirsuta* (v. d. Wulp).	Kuching, May 3, 1900.
44. *Megalocolus notator* (Walk.).	Kuching, April 24, 1900.
45. Reduviid sp.	Kuching, Sept. 16, 1899.
46. *Toxophora*, n. sp. near *javana* (Wied.).	Kuching, May 16, 1900.
47. *Bracon* sp.	Kuching, Aug. 11, 1900.
48. *Mutilla* sp. near *urania* (Smith).	Kuching, July 17, 1899.
49. *Tillicera*, n. sp. ? near *T. bibalteata* (Gorh.).	Kuching, Aug. 1899.
50. *Cladophorus atrofuscus* (C. Waterh.), ♀.	Kuching, March 15, 1900.
51. ,, ,, (C. Waterh.), ♀.	Kuching, April 14, 1900.
52. *Tenerus sulcipennis* (Gahan).	Kuching, March 30, 1900.
53. *Callimerus bellus* (Gorh.).	Kuching, Dec. 13, 1899.
54. *Callimerus catenatus* (Gorh.).	Kuching, Oct. 6, 1899.
55. *Daphisia pulchella* (Pasc.).	Kuching, June 19, 1900.
56. *Spathomeles*, n. sp. near *S. turritus* (Gerst.).	Kuching, Oct. 15, 1897.
57. *Zelota spathomelina* (Gahan).	Kuching, Dec. 12, 1899.
58. *Erythrus viridipennis* (Gahan).	Matang, 3600 ft., June 1900.
59. *Prionocerus cœruleipennis* (Perty).	Kuching, May 4, 1900.
60. *Tetralanguria pyramidata* (Fab.).	Kuching, Dec. 8, 1899.
61. *Botryonopa cyanipennis* (Baly).	Kuching, Feb. 24, 1899.



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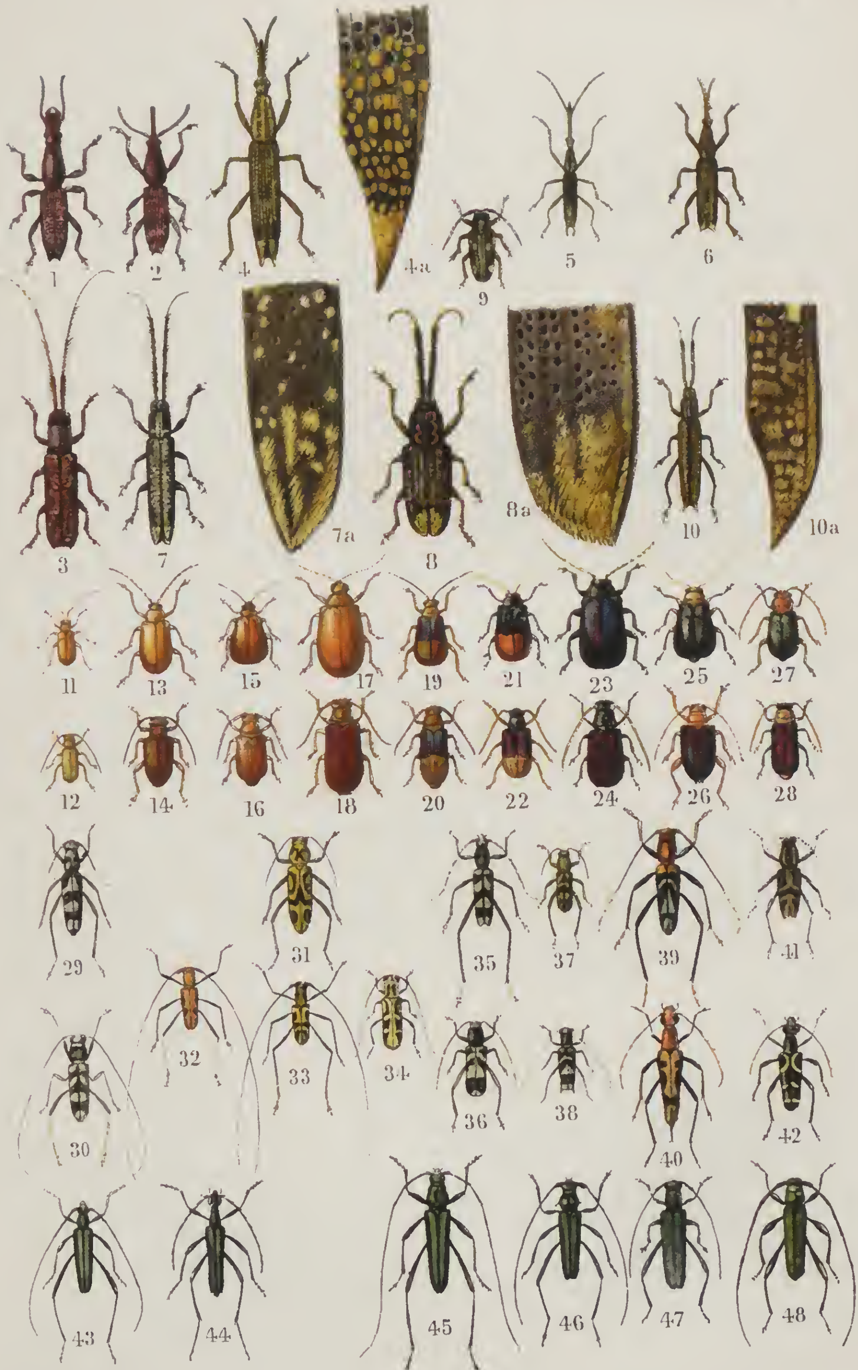
MIMETIC BORNEAN INSECTS AND THEIR MODELS.



Horace Knight del. et lith.

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MIMETIC BORNEAN COLEOPTERA AND THEIR MODELS.

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Mintern Bros Chromo.

MIMETIC BORNEAN CHALCOSID MOTHS AND THEIR MODELS.

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MIMETIC BORNEAN DIPTERA AND THEIR MODELS.

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MÜLLERIAN MIMICRY IN GROUPS OF BORNEAN INSECTS.

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Hypolimnas misippus captured at sea.

By Professor EDWARD B. POULTON, M.A., F.R.S., F.Z.S., &c.

Referring to the notes on this species in vol. xi., p. 322, and vol. xii., p. 80, of *The Entomologist's Record*, I am now, owing to the kindness of Captain E. P. Ellis, able to supply a full account of the circumstances under which he made the interesting capture of three females (two of the variety *inaria*) and two males, over 500 miles from land. The notes sent me by Captain Ellis were made by him on the sailing ship *Winefred* on a voyage from Australia, and are as follows :—

"May 5th, 1893. In 00° 36′ N. lat. and 26° 42′ W. long., a swarm of butterflies about the ship ; they appear to be all of one kind."

"May 9th, 1893. In 3° 56′ N. lat. and 27° 20′ W. long. Butterflies all over the ship ; the sailors knocking them down with their caps from one end of the ship to the other."

Captain Ellis also informs me that during these days the ship had passed through the region of the doldrums with calms and rain squalls between the N.E. and S.E. trade winds. To the best of Captain Ellis's recollection and opinion all the butterflies belonged to one swarm and were of the same kind on both occasions. The ship was then nearly on the line between Cape St. Roque and Sierra Leone, and 580 miles from the former, 960 miles from the latter. Although the African coast was far more distant than the South American, I cannot doubt that the insects came from the former. Indeed, I put down tropical West Africa as first among the suggestions thrown out in my note (vol. xii., p. 80). The only other possibility is tropical South America, a country in which *H. misippus* has comparatively recently established itself and is spreading rapidly. The insufficient observations that have been made in South America do not justify the belief that the *inaria* form of the female is present in large proportion, while two out of the three females captured at sea belonged to this variety—a proportion entirely consistent with our much more extensive series of observations upon this species in West Africa. Furthermore, the species is not sufficiently abundant in South America to render it probable that these vast swarms can have come from there. The observation throws much light upon the comparatively recent intrusion of the species into South America, and its even later spread to the Canary Islands, and goes far to explain its extraordinarily wide distribution in the Old World.

I am making a special study of this most interesting species, and

should greatly value the help of any of your readers on two points. (1) Any information which may lead to the establishment of the inclusive dates between which the late Thomas Belt was at the Montes Aureos, Brazil. (A specimen in the British Museum from the Godman-Salvin collection was collected there by Belt, and is, as far as I am aware, the earliest recorded example from the New World.) (2) The capture of large series of the species, especially of females, in any of its American localities. These are British Guiana and Brazil in South America, and the Island of Trinidad, Southern Florida in North America, and many West Indian Islands. The specimens are best sent in " papers," with exact dates and localities written upon each. The African form of the female is said to be slightly darker than the Oriental, corresponding with the darker richer colouring of its model, *Limnas chrysippus*, and, however this may be, the proportion of the *inaria* form of female differs greatly in different parts of the geographical range. A sufficient series of New World females, carefully examined and compared, may be expected to throw light upon the direction of recent lines of migration.

The specimens brought by Captain Ellis are in the Hope Department, where they can be seen at any time.—Oxford University Museum. *November*, 1900.

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CONSCIOUS PROTECTIVE RESEMBLANCE.

By Guy A. K. Marshall, F.Z.S.

In the second portion of his "Biological Suggestions" (Zool. (1899) pp. 289, 341, 443, 529; (1900) p. 116), Mr. Distant has dealt at some length with the phenomena of animal colouration, generally described under the terms of Protective and Aggressive Resemblance. It is not altogether obvious why these phenomena should have been ranked by him under the term Mimicry. I am aware that this latter word, as first used by Kirby and Spence at the beginning of the century, included *all* cases of resemblance of what kind soever; but seeing that, with our increasing knowledge of the subject, students of animal colouration have found it both useful and advisable to discriminate between resemblance in order to attract attention (Mimicry) and resemblance in order to obtain concealment (Protective and Aggressive Resemblance), there seems to be no sufficient reason why we should revert to an earlier and less exact definition, which is only apt to cause confusion.[1] (*These numerals refer to some concluding notes by Prof. Poulton.*) In his review of the matter, Mr. Distant has brought together a large number of interesting facts and observations bearing on the subject of general and special resemblance (a distinction, however, which he overlooks), containing examples from all classes of animal life. A consideration of these facts has led him to offer the suggestion that "animals of their own volition, and in their efforts to avoid their enemies, place themselves where possible in such adaptation to their surroundings, that protective resemblance and some forms of mimicry are due to animal intelligence, and not so entirely to what is generally understood as the unconscious process of natural selection" (*l.c.* 1899, p. 465). It is proposed to designate this conscious action by the somewhat unsatisfactory name of "active mimicry";* it seems doubtful whether any special name is really required for this process, but, if it be so, I would suggest that "conscious resemblance" is more suitable and more in conformity with the recognised terminology.†

* The term "active" was not invented, but adopted from Kirby and Spence (*cf.* 1899, p. 464).—Ed.

† "Conscious mimicry" was also a term stated to have been proposed by Prof. Henslow (*cf. ib.* p. 465).—Ed.

This "active mimicry" is apparently regarded by Mr. Distant as something apart from natural selection, a separate factor in evolution, for he says: "If the process of natural selection was to be applied, according to a very frequent method, as universal, then birds arising from these white and prominent eggs would seem in course of time to be doomed to destruction. But we find nothing of the kind. Natural selection is here *replaced* by the evolution of intelligence or active mimicry. True, it may be argued that birds laying white eggs would become extinct without they had gradually acquired the intelligent or automatic powers of concealment through a process of natural selection. But this is only begging the question" (*l. c.*, 1899, p. 546). (The italics are my own.) Seeing that this attitude permeates the whole discussion, it is somewhat disconcerting to read in the concluding remarks that, "to fully understand mimicry, we must appreciate general animal intelligence, and then we shall probably comprehend how much activity has been displayed by animals seeking protection by adaptive and assimilative efforts. This in no way contradicts, but supports, the doctrine of Natural Selection. The animal survives which can best hide from its enemies, and this implies that the variations which tend to adaptive and assimilative efforts, not only succeed in the battle of life, but by the selective process become dominant, and more and more accentuated with a greater need" (*l. c.*, 1900, p. 124). It is scarcely necessary to point out that the latter position, which is essentially that of those very selectionists[2] whose views Mr. Distant is combatting, is quite at variance with the former. It will therefore be necessary, for the purpose of this discussion, to neglect this remarkable contradiction.

The whole question of conscious resemblance must necessarily depend upon our ideas of animal intelligence, and in the present state of our knowledge these are unavoidably hazy and obscure. It must be recollected that our conception of mind, even in our fellow men, is based entirely on analogy, and thus the further we depart from the human type, the lower we go in the organic scale, the weaker and weaker must that analogy become, and the more careful must we be to avoid the conception that any apparently purposive actions we may observe in these lower organisms must be due to trains of reasoning such as we find in ourselves. The whole subject is, at present, merely hypothetical; but, on the other hand, we must not forget that even our most definite scientific facts are only very high probabilities.*

* I observe that Mr. Distant has strongly criticised (*l. c.*, 1899, p. 361) a somewhat similar remark by Prof. Tyler, who says that "Natural Science does not deal in demonstrations, it rests upon the doctrine of probabilities; just as we have to order our whole lives upon this doctrine." To this Mr.

It is probable that no evolutionist would deny that there must be a certain measure of truth in the contention that some animals are capable of appreciating the protective value of their colouring;[3] for, apart from observational evidence on the point, we should antecedently expect a certain amount of reasoning power in this direction according to the ordinary principles of evolution. The question is, however, whether, in the suggestions under consideration, this power has not been considerably over-estimated. An examination of the examples referred to "active mimicry" would certainly lead to this conclusion, for the arguments used in these instances are equally applicable to every case of protective or aggressive resemblance. There would be little difficulty in demonstrating the untenability of such a position, but this is unnecessary, as we are expressly warned that the suggestion of active mimicry must not be made too absolute, although no suggestion is offered as to its probable limits.

It may, perhaps, be possible to define roughly certain limits within which such consciousness cannot be recognised. Resemblances have been aptly divided by Prof. Poulton into two categories, viz.: "*Special Resemblance*, in which the appearance of a particular object is copied in shape and outline as well as in colour; and *General Resemblance*, in which the general effects of surrounding colours are reproduced" ('Colours of Animals,' p. 24); and in connection with this distinction it is interesting to note that in the most intelligent section of the animal kingdom, namely, the higher vertebrates, we find little but general resemblances, and the lower we go in the scale of intelligence, the more frequently do we observe special resemblances, that is, where colour is utilised for protective purposes.[5] But, quite apart from this, it is evident that it is practically impossible to include cases of special resemblance under the term "active mimicry," as here discussed.

Distant replies that "This is a cardinal doctrine in natural and apologetic theology, but is the very antithesis of science, natural or otherwise. The man who orders his whole life on probabilities will probably arrive at the conclusion that hope is a very good breakfast, but a most indifferent dinner." Prof. Tyler's remark appears to my mind as a sufficiently evident truth, but I may perhaps be permitted to adduce in its support the opinion of so virile a thinker as the late Prof. Huxley, who says: "We find, practically, that expectations, based upon careful observations of past events, are, as a rule, trustworthy. We should be foolish indeed not to follow the only guide we have through life. But, for all that, our highest and surest generalizations remain on the level of justifiable expectations, that is, very high probabilities." ('Collected Essays,' vol. v. p. 204.)

On the other hand, Prof. Huxley, in thanking Bateson for his well-known volume on 'Variation,' writes how glad he is to see "that we are getting back from the region of speculation into that of fact again" ('Life and Letters,' vol. ii. p. 372).—Ed.

For instance, in those wonderful cases which are found so frequently among insects, the habits of each species are so intimately correlated with its abnormal structure and colouring,[4] that it is unreasonable to believe that these characters have been developed independently by different factors; the latter by natural selection, and the former by the "evolution of active mimicry," whatever that may mean. These special structures cannot be accounted for by "active mimicry," neither can they be explained by any general theory of internal or external causes, for, as the late Mr. Romanes has well remarked, "Were it not that some of Darwin's critics have overlooked the very point wherein the great value of protective colouring as evidence of natural selection consists, it would be needless to observe that it does so in the *minuteness* of the protective resemblance which in so many cases is presented. Of course, where the resemblance is only very general, the phenomena might be ascribed to mere coincidence, of which the instincts of the animal have taken advantage. But in the measure that the resemblance becomes minutely detailed, the supposition of mere coincidence is excluded, and the agency of some specially adaptive cause demonstrated" ('Darwin and after Darwin,' p. 318, note).

Thus a strong objection may be lodged against the whole suggestion of active mimicry, as opposed to that of natural selection, in that the former suggestion is essentially incomplete and cannot explain all the facts of the case. Let us take the instance of the leaf-butterflies of the genus *Kallima*, of which Mr. Distant says: "The partiality of this insect for settling on dry and withered leaves appears a true instance of active mimicry" (*l. c.*, 1899, p. 531).[6] Upon the theory of natural selection (granted the undisputed facts of variation and the struggle for existence), it is easy to understand that any marked variations in the direction of leaf-like shapes or markings, which would afford better concealment, would tend to be preserved and further augmented, both by heredity and by the increased keenness of enemies, until the present admirable resemblance had been arrived at. "But, as Mr. Badenoch has well enquired, 'Of what avail would be the disguise were the insect prone to settle upon a flower, or green leaf, or other inappropriate surface?'" (*l. c.*). Quite true; and the fact that the insect is not so inclined is readily explainable by the Darwinian theory; for it is clear that a much greater proportion of those individuals which were prone to render themselves conspicuous by settling on inappropriate surfaces would be picked off by their enemies than of those which selected suitable resting places; and thus, by a gradual process of elimination, the progeny of those individuals, which possessed a well-defined instinct to settle upon withered leaves, &c.,

would eventually supersede those whose instincts were not so well in harmony with their colouration. On the other hand, for the suggestion of "active mimicry," it is contended that the actions of these insects are apparently so purposive that it is difficult to believe that they are not due to "conscious volition" on their part; and, in support of this contention, a large number of other similar cases are adduced, all, be it noted, equally, or more fully, I consider, explicable on the theory of natural selection. But when we stop to enquire why, or how, these butterflies have developed this peculiar colouration, the supporters of the suggestion of "active mimicry" can vouchsafe us no reply. According to this suggestion, the tiger selects the bamboo-thicket, the leopard the leafy forest, and the lion the open veldt, simply because they have individually discovered, by their own reasoning powers, that these respective localities are best suited to their particular styles of colouration;* and the question why one is striped, another spotted, and the third unicolourous, reverts to an open problem. Thus all the beautiful explanations of adaptive colouring, afforded us by Darwin's grand conception, are to be thrown to the winds if "active mimicry" be logically applied.

It will be thus seen that it is only among the most generalised types of resemblance that we may seek for signs of conscious adaptation, as opposed to quasi-mechanical instincts. But even here the foregoing objection also applies, though with less force, since the contention of coincidence may be put forward in some cases, as indicated by Mr. Romanes. But it must be borne in mind that this contention is nothing but an argument from ignorance, and, as such, is not scientifically permissible where any other reasonable and adequate explanation can be advanced. The mere citation of a number of instances of protective colouring, however purposive the actions of the animals may appear, are in themselves no *proof* of conscious resemblance; neither do they in any way weaken the theory of natural selection in this regard; for this theory not only consistently explains the reasons for, and the development of, the colouration, but also accounts for that very purposiveness upon the occurrence of which the former proposition is alone based. Again, in the case of special resemblances, if it be conceded, as a result of the arguments adduced above, that both the morphological and psychological characters have been contemporaneously perfected through the mechanical action of natural selection (and in fact the structural peculiarities cannot well be explained on this principle without the instincts), then this alone would form strong

* This is an apparent inference to Mr. Marshall, but no statement of the kind appears in the suggestions criticised.—Ed.

presumptive evidence that, at least, the great majority of cases of general resemblance are due to the same factor. For it is evident that all cases of special resemblance must, at some time or other, have passed through a general phase, and therefore we must necessarily apply the same explanation in both categories.

Nevertheless, while the orthodox Darwinist may maintain that protective colouration, together with the appropriate instincts which are necessary to render it of any use, have been ultimately developed through natural selection (save, perhaps, in a very few exceptional cases),[7] yet it is competent for him, without any contradiction, to admit that probably some few of the most intelligent animals may, in the course of their mental evolution, have arrived at such a standard as to be able to appreciate the value of their own protective actions, which were originally merely instinctive—a very different position, however, from that suggested by Mr. Distant.

But even for such an admission some definite proof is required. On looking through the large number of instances quoted by Mr. Distant in support of his suggestions, there appears to be only one case which affords anything like real *proof*, as opposed to mere suggestion. I refer to Mr. E. S. Thompson's account of the actions of a fox: "A fire had swept the middle of the pasture, leaving a broad belt of black; over this he skurried until he came to the unburnt yellow grass again, when he squatted down and was lost to view. He had been watching us all the time, and would not have moved had we kept to the road. The wonderful part of this is, not that he resembled the round stones and dry grass, but that *he knew he did*, and was ready to profit by it'. ('Wild Animals I have known,' p. 193).[8] This is a good example from Mr. Distant's point of view, but the fox is notoriously one of the most sagacious and cunning of animals, and, even if we believe that many of its actions are due to conscious intelligence, this does not in any way prove the occurrence of such intelligence in insects, fishes, or even other mammals, each of which cases would require independent proof. Further, it may be as well to point out that probably the process of reasoning in the fox would be quite different from that which would prompt a man to put on a khaki-coloured shirt when going out to shoot buck. It is improbable that any of the lower animals have any real conception of their own appearance, and it is likely that any consciousness they may exhibit in their protective actions consists rather in the general recognition that they are freer from attack in certain particular spots or types of country, than from any true appreciation of the optical phenomena to which they really owe their safety.

But it must be noted that a mere desire to hide, apart from any

colour consideration, cannot be regarded in itself as any evidence of conscious resemblance. For example: if we break a piece off a termite-heap and see that the inmates at once run back into the nest or avail themselves of the nearest cover they can find, we cannot assume that this is due to their intelligent recognition that their colours are out of harmony with their then surroundings, but we should rather attribute it to the instinctive avoidance of light shown by all such nocturnal creatures, an instinct which is preferably explained by natural selection.[9]

As a matter of fact, the most satisfactory style of evidence would probably consist in a careful and exact observation of the demeanour of protectively-coloured animals, which find themselves, by a natural accident or necessity, in an environment to which their colour is quite unsuited; or, conversely, of the behaviour of striking sports or variations of such species, when occurring in their normal surroundings. If, in such cases, the animals show a distinct appreciation of the danger of their position and alter their normal habits accordingly, then the suggestion of active mimicry will be sufficiently proved, so far as those animals and their immediate allies are concerned. But if, on the other hand, they show no such appreciation and merely adopt their usual attitudes of concealment, which in that case would egregiously fail in their purpose, then this suggestion will be very strongly discounted. It seems that a careful collection and discussion of all the authenticated observations of this description would add considerably to our knowledge of animal psychology. Perhaps, however, this has been already done, for it is impossible to keep abreast of scientific thought and work when living on the very outskirts of civilisation. I may here refer to one or two examples of this kind which tend to show that many cases of protective actions on the part of the higher vertebrates must be attributed to UNREASONING INSTINCT rather than to conscious volition.

The late Mr. Romanes very truly remarked, that "Every sportsman must have noticed that the somewhat rare melanic variety of the common Rabbit will crouch as steadily as the normal brownish-grey type, notwithstanding that, owing to its normal colour, a 'nigger rabbit' thus renders itself the most conspicuous object in the landscape. In all such cases, of course, there has been a deviation from the normal type in respect of colour, with the result that the inherited instinct is no longer in tune with the other endowments of the animal" ('Darwin and after Darwin,' p. 320). Again, to quote Mr. Distant himself, in reference to the crouching habits of the South African Francolinus, he says: "Subsequently I observed how this action

could become habitual without a suitable environment. I flushed a pair of *Francolinus subtorquatus*, one of which squatted in the same manner, but, by force of circumstances, among the short, black and charred remains of a grass fire. Here its colour stood out in bold relief, and I easily bagged it" (Zool. 1899, p. 545, note). I have on several occasions observed a similar behaviour on the part of this same bird in Mashonaland; and, indeed, the blackening of the veldt by grass fires not unfrequently gives one opportunities of realising that at least some protectively coloured animals have no mental appreciation whatever of the real relation between their own colouring and that of their environment.

There are few birds in this country which show a stronger apparent reliance on their protective colouring than the little Rufous-capped Lark (*Tephrocorys cinerea*) or the Cape Long-claw (*Macronyx capensis*); they will readily permit one to approach within a few yards of them, and will then merely run on ahead in their curious, crouching, rat-like manner. This action is certainly of considerable protective value in their ordinary surroundings, but they will do precisely the same on the open "burns," where it must be rather detrimental than otherwise. Did they really comprehend the contrast exhibited by their plumage in such spots, they would assuredly escape by flight instead of by running. Not long ago I noticed a similar case on the part of our common Side-striped Jackal (*Canis lateralis*). While travelling on a post-cart we passed a fire burning not far from the road, and strongly outlined against the burnt grass we saw the forms of two Jackals. They were a little distance apart, one sitting on its haunches, the other standing, and they were evidently watching for the rats, young birds, &c., which the fire would disturb. At our approach they merely looked round at us without concern, and so, without stopping the cart, one of my companions tried a shot with his rifle. The bullet whizzed close over the head of the standing animal, which promptly bounded into the long, unburnt grass; the other, however, which had only heard the report without feeling the shock of the bullet, merely crouched to the ground, when it was quite as conspicuous as before, and did not move until a second bullet knocked up the dust close by its side. I have further seen an identical instance of the misapplication of the protective crouching instinct on the part of the Aard Wolf (*Proteles cristatus*) in Natal; and, doubtless, such observations could be multiplied were special attention paid to them.

Anyone who has had many opportunities of observing animals must have been struck by the fact that even though they may possess a considerable amount of intelligence, this is curiously limited in many

directions. This may even occur in an unexpected way, as in the observation of Col. Pollok, cited by Mr. Distant, that the Tiger has not yet learnt that in pursuit of game nothing can be done down wind. Considerations such as these must lend a certain measure of support to the mechanical conception of natural selection. Thus, in the matter of conscious resemblance, although many animals may show undoubted intelligence in other directions, it is highly probable that, in the great majority of cases, their reasoning powers would not be sufficient to enable them to decide whether, or no, their own colouring would have a protective value in any new or unusual environment, It is far more reasonable to suppose that such knowledge as they may have in this respect would be acquired through their experience of their liability to, or immunity from, attack under such conditions, quite apart from any colour considerations. The former process would be a true instance of "active mimicry," as defined by Mr. Distant, but the latter cannot be included under that term; indeed, in such cases, experience in the individual is the equivalent of natural selection in the species.

In the preliminary portion of his paper, Mr. Distant has given us many excellent examples and arguments to show that mimicry and protective resemblance probably existed in very remote antiquity;[10] and he has done well in drawing attention to the matter, which is apt to be overlooked. But I must certainly join issue with him when he states that: "The present attitude of many champions of the cause, who seek to find, or to invent, present factors for producing these phenomena, seems fraught with peril for the whole theory; and, with the same weariness and perseverance with which the original promulgators thought out the doctrine, we must go on searching for further proofs, which will necessitate our appealing to the Cæsar of the past—the ever-growing science of palæontology" (*l. c.*, p. 302). I must confess that this appears to me to be a very remarkable assertion. In the first place, the vast majority of cases generally referred to mimicry and resemblance are concerned with colour and movement alone, structure playing but a very subordinate part therein.* Mr. Distant has himself been at some pains to show the very evident futility of appealing to

* The point discussed was the *structural* characters of the Phasmidæ. The exact quotation requires this antecedent: "We still have abundant reason for believing that, though the protective resemblance of these Phasmidæ was already acquired in Carboniferous times, the presence of Amphibia in an evolutionary sense is quite sufficient to account for it. This prompts two reflections: one, that we ought to look a long way back for the origins of these protective and mimetic guises; and the other, that we may reasonably hope to find them" (p. 302).—Ed.

palæontology for evidence as to these phenomena; thus, if we are denied the right of attempting to explain them by causes acting at the present time, we shall have to abandon the whole question in despair. But, what is more important, mimicry and resemblance are only particular aspects of the principle of natural selection, and therefore if the factors of mimicry do not exist to-day, then, *a posteriori*, neither do those of natural selection. A single glance at nature is sufficient to justify the rejection of such a conclusion, and we must, therefore, admit that the factors of mimicry *are* in actual operation now; were they not, we should have no grounds for assuming that they had operated in past geological epochs. If, therefore, we find that certain cases appear difficult of exact explanation in the present state of our knowledge, we are by no means justified in disposing of the difficulty by referring them to causes operating only in the dim past, which we can neither prove nor disprove. Rather must we continue the laborious search for further evidence, not by a study of the anatomy of extinct animals, but by seeking a deeper and more intimate knowledge of the real life-histories of living organisms; for we are still profoundly ignorant of the immensely complex factors which go to make up the conditions of life of the very commonest animal upon this earth.

Nevertheless, it must be conceded as possible that there may be certain cases of mimicry or resemblance which cannot be attributed to exact causes acting at the present time; but these would be only exceptional, and would probably be due to a recent change in the enemies or the general environment of the species. I say "recent" advisedly, for we have very good grounds for believing that complicated protective characters would gradually disappear soon after the need for them ceased, whether this disappearance be attributed to pammixis or to disuse.

Later on, in the papers under consideration, we find an excellent suggestion that all examples of mimicry and resemblance should be classified under various headings, such as—Demonstrated—Suggested or Probable—Disputed or Mistaken—Purposeless—or Active. If such an arrangement could be thoroughly and carefully carried out, it would be of considerable value to students of these phenomena. Mr. Distant could, of course, only give us a mere sketch of the subject; but it is remarkable that there is not even a reference to the lengthy and important paper by Prof. Poulton, who has so thoroughly identified himself with this line of research, on "The Experimental Proof of the Protective Value of Colour and Markings in Insects in reference to their Vertebrate Enemies" (Proc. Zool. Soc. 1887, pp. 191–274), in which all the reliable experiments on British insects, up to that date,

are tabulated and discussed.* Unfortunately, however, the classification of several of the cases given by Mr. Distant is open to criticism. For example: in the instances of resemblances in birds, given by Mr. J. H. Gurney (*l. c.*, 1899, p. 460), every case relates to species of the same genus inhabiting different areas—in fact, representative species, or even local races; and the resemblances between them are simply due to close kinship, and have nothing whatever to do with the subject of mimicry. Again, a reference to the suggested mimicry of the Cape Hunting Dog (*Lycaon pictus*), of the Spotted Hyæna (*Hyæna crocuta*), is placed under the heading of "Suggested or Probable Mimicry" (*l. c.*, p. 449), although Mr. Lydekker's remarks, showing the difficulty of accepting this proposition, are quoted. Indeed, I have always been at a loss to understand how such a strong and fearless animal as the former—of which Selous has recorded that it "is capable of overtaking and attacking single-handed such a powerful animal as a male Sable Antelope" ('Hunter's Wanderings in Africa,' p. 357)—could be supposed to derive any benefit from resembling a cowardly brute like the Hyæna. To anyone acquainted with the two animals in nature, it is abundantly evident that, whatever mimicry there may be between them, it would be in just the reverse direction; that is, the skulking Hyæna would materially benefit by being mistaken for the bold and gregarious Hunting Dog.[11]

I need only refer to one more example—namely, that of the Honey Bee (*l. c.*, p. 356). It is well known that various species of the dipterous genus *Eristalis* mimic Bees; and Mr. Distant quotes the experiments of Prof. Lloyd Morgan with Chickens, and Mr. R. J. Pocock with Spiders, which demonstrate the value of this mimicry. Yet this instance is not placed in the "Demonstrable" category, but in that of "Suggested or Probable," on the ground that "the Bee itself is not absolutely protected by its sting." If such a classification were adhered to, there never would be a case of demonstrated mimicry; but it must be noted that, on the same page, it is explained that: "By the term 'Demonstrable' is implied all those instances where protection, absolute *or partial*, has been, or can be, demonstrated by experiment or actual observation."[12]

It now only remains to discuss the objections raised by Mr. Distant

* The writer may not have referred to every paper that Prof. Poulton has written, but he certainly did write (p. 451): "Poulton has focussed many observations respecting instances in the Insecta, largely augmented by information received from the well-known coleopterist C. J. Gahan" (*cf.* Journ. Linn. Soc. xxvi. pp. 558–612 (1898)); a much later paper than that referred to by Mr. Marshall.—Ed.

to certain cases which are generally referred to protective resemblance. After stating that "colour alone may prove a false analogy to protection" (*l. c.*, p. 350), and referring to the strongly protective colouring of a certain South American butterfly, *Ageronia feronica*, he says: "This observer, however, at the same time refers to the statement of Bigg Wither, that this very insect is called the Whip-Butterfly, owing to the sharp whip-cracking sound made by its wings when battling by its fellows in the air,[13] and that this sound makes it the easy prey of a forest bird, locally known as 'the Suruqua,' who thus detects and secures it. Here the apparent protection by "protective resemblance" is invalidated by a peculiar and unusual sound-producing quality, which is as equally dangerous as its colour is reported protective. A similar remark may be made as to the musical *Cicadidæ*. How often have the usual green and brown colours of these insects been adduced as an example of protective resemblance; . . . but when we desire to capture them the shrill noise proclaims their retreat, and their assimilative colouration avails them little." Again, in commenting upon Mr. Tutt's graphic account of the protective colouring of the Lappet Moth (*Lasiocampa quercifolia*), he says: "Here the expression, 'trained eye,' of the entomologist, would suggest a more developed 'trained eye' of the moth's natural enemies, and hence any theory of *protective* mimicry is much discounted (*l. c.* p. 455). From these quotations it may be gathered that Mr. Distant's attitude towards the subject is somewhat as follows:—When we find that the colouring of any animal assimilates well with that of its environment, but, at the same time, that this animal is apt to render itself more or less noticeable by certain movements or noises, then we are not justified in regarding its colouration as an efficient protection, and the case must therefore be removed from the category of protective resemblance. Tempting as such a conclusion may be to the opponents of Darwinism,* it appears to me to be wholly erroneous. The fundamental fallacy lies in the gratuitous assumption that the protection afforded must be absolute; for otherwise there is no ground whatever for the objection raised. In the first place, I am not aware that such absolute protection has been anywhere observed in nature, and, indeed, were the above proposition a sound one, the principle of protective resemblance would have to be entirely abandoned. But, as a matter of fact, this principle predicates no such complete immunity from attack; in truth, the very essence of the theory of natural selection negatives any such

* Darwinism does not derive its sole support from theories of "mimicry," and the writer of the papers criticised was not aware that he was to be counted among "the opponents of Darwinism."—ED.

supposition; for, according to this theory, protective resemblance, as we now see it, has been arrived at by the gradual accumulation and improvement of colour variations which make for concealment, and the protective value of such variations must essentially be, or have been, of only a partial character. Admitting that the gambols of the Whip Butterfly (presumably of a sexual character) lead the insect into a certain amount of danger, yet, to ask us to believe that it thereby "invalidates" the protection afforded it, when at rest, by its assimilative colouring, against other enemies, and perhaps even against the "Suruqua" itself, is, as Mr. Bateson puts it, referring to a different assumption, "to ask us tó abrogate reason." Further, the not unusual fact, that animals exhibiting a very high grade of resemblance are yet subject to a considerable amount of persecution, in no way invalidates, but rather strengthens, this principle; for it is evident that such a degree of resemblance can only have been developed in response to a similarly high degree of persecution, acting either now, or within recent times.

It will thus be seen that, on general considerations alone, the above objections to the principle of protective resemblance must be at once ruled out of court. It may be as well, however, to discuss the case of Cicadas in more detail. In the first place, I cannot agree with Mr. Distant that these insects are easily captured owing to their shrill cries. All high-pitched, vibrating sounds of this kind are very difficult to localise exactly, and with Cicadas I have noticed very frequently, both with myself and others, that the distance of the insect is invariably much underestimated.[14] But even when the tree on which the Cicada is sitting has been ascertained, it must be very cautiously approached, for many species are able to detect one's presence at a distance of fifteen to twenty yards in open country, and, on so doing, they will at once cease their call; and although they will generally permit a much closer approach than this, yet it is always extremely difficult to locate the exact position of the sound on the tree. Their habits, however, vary in this respect, and among the dozen or more species which I have observed in various parts of South Africa, I have found it to be a very general rule that their wariness is inversely proportionate to their protective resemblance; those species which live on rough, knotted bark, or among dense foliage, permitting one to approach much nearer than do those that rest on bare, smooth trunks or small twigs. The above remarks apply to the calling of a single insect; but, when a number are calling together, it is still more difficult to localise any particular cry; and, indeed, I have on several occasions been driven out of a patch of machabel bush by the con-

tinuous ear-piercing scream of a number of the large *Pœcilopsaltria horizontalis*, Karsch, which seems to make the whole air pulsate, without betraying the exact locality of a single individual. Although in many cases I have actually tracked down individuals by their cry, in order to learn the calls of the different species, yet such a method is far too laborious for ordinary collecting purposes. So experienced a collector as Dr. Percy Rendall says: "In the Transvaal I have also taken them at rest on tree-trunks, but I do not think they were taken in consequence of their song having thus localized them. At Zomba I caught a large species by actually localizing its noise, but that was the only instance of the kind that I remember" ('Zoologist,' 1897, p. 520).

It must not be supposed that I do not recognize that the Cicada's cry must, under certain circumstances, be dangerous for individuals as, indeed, are many other secondary sexual characters; but Mr. Distant appears to have overestimated the danger, and the contention that this noise invalidates their admirably protective colouration appears to be an inverted way of looking at the question. It is more reasonable to suppose that the protective resemblance of these insects is so efficacious, that they have been able to develop these extraordinary cries through the process of sexual selection (or perhaps even natural selection, supposing æsthetic appreciation on the part of the female be denied), without unduly endangering the safety of the species. On this view, the Cicada's song, far from proving that the insect's colouring is inefficient for protective purposes, would stand as a testimony of its very high efficacy. In fact, I venture to think that, in the vast majority of cases in which animals produce conspicuously loud sounds, they will be found to possess either highly protective colouration or habits, or else distasteful or other qualities which render concealment unnecessary.

In conclusion, I can only hope that sufficient has been said to show that there are good grounds for opposing the suggestion that active mimicry is of any general occurrence in the animal kingdom; and, further, that the attempt to minimise certain phenomena of ordinary protective resemblance, in order to bring them within the scope of that principle, is not justifiable upon the evidence adduced. The subject, however, is such a wide one, that it is impossible to deal adequately with all its aspects within the limits of a paper such as this.

REMARKS ON THE PRECEDING PAPER.

By Edward B. Poulton, M.A., F.R.S.
(Fellow of Jesus College, Oxford; Hope Professor of Zoology in the University.)

My friend Mr. Marshall has asked me to make any alterations or corrections in his paper. I find, however, that I so entirely agree with the whole of the argument that I have merely added a few confirmatory notes to certain passages in the paper, which are in each case marked by a number.

[1] H. W. Bates, in his classical paper, also used the term mimicry in the wider sense employed by W. L. Distant. The majority of naturalists have since followed A. R. Wallace in keeping Protective and Aggressive Resemblance distinct from Mimicry—a course which appears to be convenient, inasmuch as the distinction in terms corresponds to a real distinction in the modes of defence. In the former, an animal resembles an object which is of no interest to its enemy, and in so doing becomes concealed; in the latter, an animal resembles an object which its enemy knows well and fears or dislikes, and in so doing becomes conspicuous. Other superficial resemblances—such as those produced by protective resemblances in common, warning colours in common (Müllerian mimicry), and functions in common (analogical or adaptive resemblances of Darwin)—are excluded from mimicry as here defined.

[2] See the discussion on "Organic Selection," reported in 'Science,' N.S. vol. vi. No. 146, Oct. 15, 1897, where this view was sustained.

[3] Probably most evolutionists would hesitate before committing themselves to such a conclusion. Highly intelligent animals, such as birds, crouch and hide when very young at every unusual sound. This action is performed instinctively and unintelligently, and is apparently an automatic response to stimulus. When the stimulus has been repeated, and no danger is apparent, the young birds cease to crouch. We are not justified in considering that their intelligence has done more than enable them to inhibit an unnecessary response. There is no reason to think that they have any understanding of the meaning of the response itself. See Lloyd Morgan's 'Habit and Instinct' (London, 1896).

[4] It should be remembered that the structure and colouring are themselves made up of many complex factors, all of which must co-operate if the mimetic or protective resemblance is to be effective. See Linnean Soc. Journ., Zool., vol. xxvi. pp. 576–578.

[5] That is to say, where the high cerebral development exists which would, according to W. L. Distant, tend to produce mimicry and protective resemblances, precisely there these adaptations are lowly developed as compared with Insecta, where we meet with far less intelligence and far more of the unvarying repetitions of pure instinct, incapable of improvement by learning, and, within their rigid limits, too perfect to require it. Where the conditions are most favourable for "active mimicry," mimetic and cryptic adaptations are least prominent; where they are least favourable, these adaptations become most conspicuous.

[6] So far as I have been able to collect evidence, *Kallima* does not rest on dry and withered leaves, but in situations, such as trunks and branches, in which dead leaves would not attract attention. H. J. Elwes has stated that it freely expands its wings when settled, and looks anything but leaf-like; but this is probably when it is thoroughly on the alert, during the short pauses between successive flights. C. Swinhoe has informed me that it invariably rests head downwards, like a dead leaf hanging by its stalk, so that all the figures and preparations seen in this country representing its natural attitude are wrong.*

It is quite impossible to explain the protective attitude of this or any other insect on the principle of "active mimicry," unless we are going arbitrarily to assume that certain defensive activities are to be explained in this way, while others, equally necessary and equally elaborate, cannot be thus interpreted. Consider, for instance, the concealment often brought by the cocoon—the selection of an appropriate situation, the building into the walls of a part of the surrounding surface, &c., &c. Upon the principle of "active mimicry," "the view would be, I suppose, that the ancestral larva spun a cocoon which was not much of a success, and was in consequence attacked by enemies; that the larva observed these attacks, and accordingly improved its cocoon. But that is not the way in which the struggle for existence is waged with insects. If the larva failed, it failed, and that would be the end of the matter. It has no chance of improvement; it has no opportunity of learning by experience. Its only chance of survival is to avoid experience of foes altogether; experience is the most dangerous thing in the world for an edible insect. This becomes still more obvious when we remember that failure or success is almost always determined long after the cocoon is made. The caterpillar, perhaps, spins the cocoon in autumn, but the real stress of competition will come in winter, when insect-eating animals are pressed hard with hunger, and search high and low for food. But the caterpillar is by

* *Cf.* Eha, 'Natural Science,' vol. ix. p. 299.—Ed.

this time a chrysalis, and of course has no opportunity of improving the cocoon. The selective test is applied long after the operation has been performed, and when there is no possibility of gaining by experience. We are thrown back, then, solely upon natural selection, which acts on the nervous system of the caterpillar, and thus compels it to make the cocoon in a certain way. In other words, those caterpillars which are impelled by their nervous system to make ill-formed conspicuous cocoons have no chance of living, and, in future stages, producing offspring. Hence the selection caused by the keen sight of foes first raises, and then maintains at a high level, the standard of cocoon-making."

"This contention as to the uselessness and danger of experience applies to the whole of those smaller defenceless animals which have no chance of fighting with their enemies, or of escaping when once they have been detected" ('Proc. Boston Soc. Nat. Hist.' vol. xxvi. p. 391).

It would be a most gratuitous indulgence in unnecessary hypothesis to insist that the appropriate attitude which gives a meaning to form and colour, and itself receives a meaning from these, originated in one way in the caterpillar, and in another and totally different way in the imago which develops from it.

[7] See note (3).

[8] The observation does not prove more than that the fox seeks cover and hides when he sees that he is observed by man. The burnt surface did not afford cover, and the fox sought it elsewhere. It would be very rash to assume from the observation that the fox knew anything about his own protective colouring.

[9] Or the numberless examples of insects which fall motionless when their food-plant is shaken.

[10] There are many reasons for considering that colours and patterns change very rapidly when no longer sustained by natural selection. When animals become cave-dwellers, or inhabit the greatest depths of the ocean, their colours are profoundly modified and often tend to disappear. This happens in forms closely allied to others which still retain the normal colouring and live in the light.

The majority of domestic animals have been immensely modified in this respect in a measurable number of years. In some cases these changes have been brought about without the aid of specially directed artificial selection. Thus a large proportion of our fowls produce white eggs instead of the brown of the ancestral species.

Again, the enormous difference between the colours and patterns of certain closely allied species is evidence for ease and rapidity of change rather than stability in this element of structure. The argument becomes stronger when we consider the cases of sexual and seasonal,

and other di- or poly-morphism in the different individuals of the same species. A single instance will make this clear. There are certain genera of butterflies, such as *Dismorphia* (in the wide sense), *Pseudacræa*, and *Hypolimnas* (also in the wide sense), of which almost the whole of the numerous species are mimetic. Within the limits of each genus the most divergent models have been followed, so that utterly different colours and patterns have been produced in forms which are still closely related, and in other structural features exhibit no corresponding differences. In the most extreme case known to me, immense differences occur in the different races of a form which systematists consider as a single species, viz. *Hypolimnas bolina.* If we compare the Indian form of female with those of the Malayan region, Australia, and Polynesia, including Fiji (in which the local race itself contains the most widely divergent forms), and remember that no corresponding differences exist which would justify us in conferring specific rank in any of the cases, we are driven to the conclusion that colour and pattern are the most superficial of all specific characters,—of all the least likely to persist unchanged when the models upon which they were founded have long since disappeared.

In one special case which I have observed, there is evidence that changes in the nervous system have outlasted the markings which once gave a meaning to them. Some of the remarkable larvæ of the genus *Ophideres* have two eye-spots at the junction of the anterior and middle third of the body. They have the instinct of bending the anterior third so that it rests under the middle one, and thus the eye-spots are brought into an appropriate position apparently at the anterior end of a somewhat snake-like body. But a caterpillar of this genus which I found in Teneriffe assumed the attitude, on irritation, although the eye-spots were almost completely wanting.

[11] It is worth considering whether the Müllerian principle may have been operative in this case.

[12] Of course, no natural selectionist has ever been so unreasonable as to contend for *absolute* protection. In every species, whether defended by the most distasteful or dangerous qualities, or the most effective concealment, no more can be achieved than to keep up the average numbers under average conditions, and this means that an immense majority of individuals are doomed to failure. As regards concealment, success merely means that enemies have so far to work for their living that in the time at their disposal they cannot do more than reduce the number of individuals to the average. Warning colours and unpalatable or otherwise unpleasant qualities are more complex as a means of defence, depending as they do for their success upon the co-existence of other more desirable food. Their operation,

under favourable circumstances, is probably to reduce the number of enemies, this success being compensated, however, by the more persistent attacks of certain special enemies—the result being the same as in the cryptic colouring, namely, to keep up the average number of individuals.

[13] Darwin remarks on the sound made by this species ('Voyage of the Beagle'), which he witnessed during his travels in South America. He believed that the sound was of sexual significance, and in his essay on sexual selection compared it to that made by the males of *Halias prasinana* during courtship—a sound which I have myself once heard. The display or exercise of secondary sexual characters is probably often a danger to the individual, although I fail to see how it is possible to argue from this that the cryptic colouring and attitudes of other phases of life are thereby rendered inoperative and valueless. The sound-producing time is one of high activity and rapid movement in both the species of Lepidoptera mentioned; in the case of the common English moth it is indulged in so rarely, that comparatively few naturalists have ever heard it, while in *Ageronia* it is not likely to be produced during more than a very small proportion of the life of the male. As to its cryptic colouring and, of even more importance, the corresponding instinctive attitudes and movements, Darwin made special remark in the volume already mentioned.

[14] I have noticed the same thing in North America. Not only was the distance very difficult to estimate, but the direction from which the sound came equally hard to trace.

[In closing this discussion, which has now extended beyond the limited space of 'The Zoologist,' as writer of the incriminated "Suggestions," I ought perhaps to make some rejoinder. This is unnecessary to my friend Mr. Marshall's objections, as they principally express an ably stated *difference of opinion*, and I have merely added footnotes to make his quotations from my suggestions a little more ample and representative. Prof. Poulton, in forwarding his "Notes," with his usual fairness, wrote: "My remarks are more of a reinforcement of Marshall's arguments than a direct answer to your paper, *which I have not seen*. I expect, however, from Marshall's MS., that they do affect the drift of your argument, and are therefore in the nature of a reply." This statement of course disarms any rejoinder. Besides which a comparison of Poulton's notes to Marshall's opinions also discloses a diversity of view, though the first named states he entirely agrees with Mr. Marshall's argument. Thus Mr. Marshall writes (*ante*, p. 538), "It is possible no evolutionist would deny," and Prof. Poulton to this adds the note, "Probably most evolutionists would hesitate before committing themselves to such a conclusion." Again, they both differ as to the active mimicry of the Fox (*cf*, pp. 541, 552). A triangular discussion is therefore out of the question, and we may continue to differ in opinion and search together for facts.—Ed.]

DR. FREDERICK A. DIXEY, M.A., M.D.,
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ON LEPIDOPTERA FROM THE WHITE NILE, COLLECTED BY MR. W. L. S. LOAT, F.Z.S.; TOGETHER WITH FURTHER NOTES ON SEASONAL DIMORPHISM IN BUTTERFLIES.

[*From the* TRANSACTIONS OF THE ENTOMOLOGICAL SOCIETY OF LONDON,
June 2, 1903.]

IX. *On Lepidoptera from the White Nile, collected by* Mr. W. L. S. Loat, F.Z.S.; *together with further notes on Seasonal Dimorphism in Butterflies.* By Dr. Frederick A. Dixey, M.A., M.D., Fellow of Wadham College, Oxford.

[Read March 18th, 1903.]

Plate VII.

Mr. W. L. S. Loat, during his tenure of office as superintendent of the Nile Fish Survey under the Egyptian Government, spent more than three years in a scientific investigation of the waters of the Nile and its tributaries. Though his biological activities were mainly engaged in other directions, he took several opportunities of collecting butterflies; and the specimens captured by him in April 1901, and in January and March 1902, are in many respects of great interest. They are generally in excellent condition, and are accompanied by ample data; but the collection (which has been liberally presented by Mr. Loat to the Hope Museum at Oxford) derives what is perhaps its greatest value from the fact that the specimens are marked in such a manner as to allow all those caught at one time and in one spot to be grouped together. The captor informs me that on these occasions no voluntary selection was made on his part; that he tried, in fact, to catch all he saw; so that each of his "bags" may be taken as a fair sample of the butterfly life that was at that particular time on the wing.

The localities of Mr. Loat's captures are as follows:—

I. White Nile; Gharb-el-Aish, near Kaka; about 11° N. Lat.
II. White Nile; near Kaka; about 10° 30′ N. Lat.
III. Bahr-el-Gebel (Nile); near Mangala; about 5° N. Lat.
IV. Bahr-el-Gebel (Nile); Gondokoro; 4° 43′ N. Lat.

Several of the species obtained from all these localities are well known to be seasonally dimorphic. As will be seen later, the present collection contains a preponderance

of "dry-season" forms. The large proportion of Pierines to the whole number is remarkable; as also is the general resemblance borne by the whole assemblage to the butterfly fauna of Aden. It was remarked by Dr. Butler in Proc. Zool. Soc., 1901, p. 25, that the collection made by Captain Dunn on the Bahr-el-Zeraf (White Nile) had a very Aden-like aspect, and in particular that it contained all the forms of *Limnas chrysippus*, Linn., just as they occur at Aden. In Somaliland, as is well known, the prevailing form of *L. chrysippus* is *L. klugii*, Butl., with a sprinkling of its modification *L. dorippus*, Klug; in other respects the present collection recalls the Somaliland fauna almost as distinctly as it does that of Aden.

It will be noticed that Mr. Loat's insect-collecting was limited to a very few occasions, and to only three months in the year. This will no doubt account for the absence from his collection of a few species which occur in that of Captain Dunn (*loc. cit.*). Among such are *Precis boöpis*, Trim., *Atella phalantha*, Drury, and especially *Hypolimnas misippus*, Linn. There is no new species among Mr. Loat's captures, but they include the male of *Pinacopteryx venatus*, Butl., of which the female only has hitherto been known to science.

Subjoined is an account of the places and dates of capture, as carefully recorded by Mr. Loat, together with a list of the specimens taken on each occasion. It has been thought worth while to preserve his details, even to the time of day at which the captures were made.

I. White Nile; Gharb-el-Aish, near Kaka; about 11° N. Lat.

1901, April 13.

A. Between 1 and 2 p.m.

PIERINÆ.

Teracolus glycera, Butl.

Teracolus glycera, Butl., Proc. Zool. Soc., 1876, p. 144; Ann. Mag. Nat. Hist., 1897, vol. ii, p. 461; Proc. Zool. Soc., 1901, p. 25.

4 ♂, 3 ♀. This, as Dr. Butler remarks, is a form of the *T. antigone* group. It is barely, if at all, distinguishable from *T. evagore*, Klug (*T. saxeus*, Swinh.). See below, p. 161.

HESPERIIDÆ.

GEGENES NOSTRODAMUS, Fabr.

1 ♀; with sharper wings and paler than Mr. Bennett's Socotran example (also a ♀).*

B. Between 3 and 5 p.m.

DANAINÆ.

LIMNAS CHRYSIPPUS, Linn.

L. chrysippus, Linn., 4 ♂; *alcippoides*, Moore, 2 ♂; *alcippus*, Cram., 1 ♀; *klugii*, Butl., 1 ♂; *dorippus*, Klug, 1 ♂.

These are of the colouring usual in examples from the northern districts of the "East African" subregion. The *chrysippus* are duller and darker in hue than specimens from Socotra, and the subapical white spots are less discrete. The specimen of *klugii* is somewhat paler than the average of that form. It is remarkable that all five variations of *chrysippus* are represented in these nine examples taken at the same time and in the same place.†

NYMPHALINÆ.

BYBLIA ILITHYIA, Drury.

1 ♀; intermediate between "wet" and "dry."

PRECIS CEBRENE, Trim.

1 ♀; wet.

PIERINÆ.

TERACOLUS GLYCERA, Butl.

6 ♀.

BELENOIS MESENTINA, Cram.

2 ♂, 3 ♀; wet.

LYCÆNINÆ.

CHILADES TROCHILUS, Freyer.

1 ♂, 1 ♀.

TARUCUS THEOPHRASTUS, Fabr.

1 ♀; rather small and dark.

* Proc. Zool. Soc., 1898, p. 382.

† On the varying forms of *Limnas chrysippus*, Linn., with their distribution, see Poulton in Trans. Ent. Soc. Lond., 1902, pp. 473–482, *ibique citata;* to which may be added a note by the present writer in Proc. Zool. Soc., 1900, pp. 10, 11.

POLYOMMATUS BÆTICUS, Linn.

2 ♀; small.

HESPERIIDÆ

GEGENES NOSTRODAMUS, Fabr.

1 ♂.

April 14.

Between 9 and 10 a.m.

DANAINÆ.

LIMNAS CHRYSIPPUS, Linn.

L. klugii, Butl., 1 ♂.

NYMPHALINÆ.

VANESSA CARDUI, Linn.

1 ♀.

PIERINÆ.

TERACOLUS GLYCERA, Butl.

1 ♂, 1 ♀.

BELENOIS MESENTINA, Cram.

1 ♂; wet.

LYCÆNINÆ

TARUCUS THEOPHRASTUS, Fabr.

1 ♂.

TARUCUS TELICANUS, Lang.

1 ♂; rather small.

POLYOMMATUS BÆTICUS, Linn.

1 ♀.

HESPERIIDÆ.

GEGENES NOSTRODAMUS, Fabr.

2 ♂.

At the time of the two days' collecting above recorded, the dry weather was breaking up. Thunder was heard in the distance, and the rains were just about arriving. The next batch of butterflies was caught at a point on the Nile a little further south, and a week later in the season.

II. White Nile; near Kaka; 10° 30′ N. Lat.

1901, April 21.

A. Between 9 and 11 a.m.

DANAINÆ.

Limnas chrysippus, Linn.

L. alcippoides, Moore, 2 ♂; *alcippus*, Cram., 1 ♂; *klugii*, Butl., 3 ♂.

NYMPHALINÆ.

Precis cebrene, Trim.

1 ♂; wet.

PIERINÆ.

Teracolus glycera, Butl.

1 ♂.

Teracolus daira, Klug.

3 ♂, 2 ♀; all somewhat lightly marked.

Teracolus leo, Butl.

1 ♂, "dry," but with no pink shade beneath; 1 ♀, white, with very slight orange flush. Inclined towards "wet."

Teracolus phisadia, Godt.

1 ♀; with orange flush on upper surface of fore-wing, and decided reddish shade beneath.

Teracolus protomedia, Klug.

2 ♀.

Belenois gidica, Godt.

Northern form (*B. abyssinica*, Luc.), 2 ♂, 3 ♀. The males tend to the wet form; one has the wings very sharply pointed. Of the females, one is wet, one intermediate, and the remaining one verges towards dry.

Belenois mesentina, Cram.

1 ♂, 1 ♀; wet.

LYCÆNINÆ.

Chilades trochilus, Freyer.

1 ♀.

Polyommatus bæticus, Linn.

2 ♀.

HESPERIIDÆ.

CHAPRA MATHIAS, Fabr.

1 ♂.

B. Between 3 and 5 p.m.

DANAINÆ.

LIMNAS CHRYSIPPUS, Linn.

L. chrysippus, Linn., 1 ♂; *alcippus*, Cram., 3 ♂; *klugii*, Butl., 3 ♂.

PIERINÆ.

TERACOLUS PHLEGYAS, Butl.

1 ♂, 1 ♀ (yellow); both wet.

TERACOLUS EUPOMPE, Klug.

1 ♂, 1 ♀. Both of these are "dry" in character, but the male is without the pinkish shade beneath, and the female only has it to a moderate extent. Mr. Loat describes the flight of the male in this and the preceding species as "wild." *

TERACOLUS GLYCERA, Butl.

1 ♂, 2 ♀.

TERACOLUS DAIRA, Klug.

1 ♂.

TERACOLUS LEO, Butl.

1 ♀; yellow, with orange flush. Under-side pinkish, as in the dry-season form.

TERACOLUS PLEIONE, Klug.

1 ♀; intermediate, verging towards wet.

TERACOLUS PHISADIA, Godt.

5 ♂, 1 ♀. Three of the males are full wet-season forms, the other two show an infusion of flesh-colour in the yellow of the under-side. The female is less reddish beneath than the specimen of the same sex taken earlier on the same day.

* Cf. Mr. G. A. K. Marshall's observations on the flight of "purple-tips."—Trans. Ent. Soc. Lond., 1902, pp. 354, 371; see also Trimen, "South-African Butterflies," vol. iii, 1889, p. 107.

TERACOLUS AMELIA, Luc.

1 ♀. Dry-season; no basal duskiness on the upper surface.

TERACOLUS PROTOMEDIA, Klug.

3 ♀.

BELENOIS GIDICA, Godt.

Northern form (*B. abyssinica*, Luc.). 1 ♂, wet; 2 ♀, dry.

BELENOIS MESENTINA, Cram.

2 ♂, 2 ♀; all wet.

III. BAHR-EL-GEBEL (Nile); near MANGALA; about 5° N. Lat. More or less open wooded country, with scrub and dried grass in places; near the river.

1902, January 8.

Between 3.30 and 5 p.m.

PIERINÆ.

TERACOLUS EUPOMPE, Klug.

1 ♂, 1 ♀, intermediate; 1 ♀, dry. All these have more or less basal duskiness.

TERACOLUS EVARNE, Klug.

7 ♂, 1 ♀; all dry.

TERACOLUS EPIGONE, Feld.

T. microcale, Butl. See Ann. Mag. Nat. Hist., 1897, ii, p. 472.

3 ♀; all dry.

TERACOLUS GLYCERA, Butl.

7 ♂, 4 ♀.

TERACOLUS DAIRA, Klug.

2 ♂, 1 ♀.

BELENOIS SEVERINA, Cram.

Form *boguensis*, Feld. 1 ♂, intermediate.

January 9.

Between 9 and 11 a.m.

PIERINÆ.

TERACOLUS EUPOMPE, Klug.

2 ♂, 1 ♀, intermediate; 1 ♀ dry.

TERACOLUS EVARNE, Klug.

19 ♂, 3 ♀; all dry. The dry-season character especially well-marked in the females.

TERACOLUS EPIGONE, Feld.

1 ♂, 3 ♀; all dry.

TERACOLUS GLYCERA, Butl.

11 ♂, 1 ♀.

TERACOLUS DAIRA, Klug.

5 ♂, 1 ♀.

BELENOIS SEVERINA, Cram.

1 ♂, wet. Form *boguensis*, Feld., 3 ♂, 1 ♀ (yellow); all dry.

BELENOIS MESENTINA, Cram.

2 ♂, 1 ♀, wet; 1 ♀, intermediate.

ERONIA CLEODORA, Hübn.

1 ♂, wet.

LYCÆNINÆ.

TARUCUS THEOPHRASTUS, Fabr.

1 ♂, 1 ♀. The male corresponds very closely with specimens in Coll. Hope from Syria. The female, which is of the blue form, comes very near to *T. sybaris*, Hopff.

AZANUS JESOUS, Guér.

1 ♂.

LYCÆNESTHES AMARAH, Guér.

1 ♂.

In a letter to Prof. Poulton, which he kindly permits me to quote, Mr. Loat describes the present collecting-ground as follows:—"The country was flat, ground hard and dry, very little undergrowth, a few large trees, open bare patches of ground, a good deal of thorny scrub in

clumps, and every here and there tufts of dried grass. The thorny scrub was mostly composed of a low-growing shrub bearing a small whitish flower with a slight nondescript scent; this seemed rather attractive to the whites and their allies." The great preponderance of Pierines in this two-days collection at Mangala will be noticed.

The remaining captures were all made at Gondokoro or in its immediate vicinity. With respect to them Mr. Loat writes as follows:—"The series caught at Gondokoro [Jan. 12, 16] were collected on a strip of land cleared of elephant-grass and weeds, and turned into a kind of garden with sweet potatoes, etc., growing in it, and a few wild flowers about, close to the edge of the river. The *L. chrysippus*, with hardly an exception, and also the *Acræas* were obtained on, or close to, the same strip of ground, some of the remainder [Jan. 13, March 8] were taken on ground like that described at Mangala. The weather on January 8, 9, 12, 13, was dry, sunny and warm. The rainy season generally begins [at Gondokoro] about the 15th of March, but this year (1902) it commenced about one month earlier; that is to say, we had occasional showers and squalls, with long intervals of fine weather. About the end of March the rains start with a certain amount of regularity, and last off and on till about October." In the neighbourhood of Kaka, 6° further north, the rains are later. As was stated above, at Gharb-el-Aish, on April 13 (1901), they were only just beginning.

IV. Bahr-el-Gebel (Nile); Gondokoro; 4° 43′ N. Lat. Strip of ground by the river.

1902, January 12.

Between 3 and 4 p.m.

DANAINÆ.

Limnas chrysippus, Linn.

L. chrysippus, Linn., 4 ♂ (one with slight white powdering round gland-patch); *alcippoides*, Moore, 1 ♂; *alcippus*, Cram., 2 ♂; *klugii*, Butl., 2 ♂; *dorippus*, Klug, 1 ♂.

ACRÆINÆ.

Acræa vinidia, Hewits.

31 ♂, 1 ♀. "Very numerous; takes a long time to die when put in the killing-bottle."—W. L. S. L.

NYMPHALINÆ.

NEPTIS AGATHA, Cram.

1 ♂.

PIERINÆ.

TERIAS BRIGITTA, Cram.

1 ♂, wet. The occurrence in January of this well-marked wet-season form is remarkable.

PAPILIONINÆ.

PAPILIO PYLADES, Cram.

1 ♀. "Rare."—W. L. S. L.

LYCÆNINÆ.

POLYOMMATUS BÆTICUS, Linn.

1 ♀.

V. GONDOKORO and neighbourhood. Ground as at MANGALA.

January 13.

Between 3 and 3.30 p.m.

DANAINÆ.

LIMNAS CHRYSIPPUS, Linn.

L. chrysippus, Linn., 2 ♂; *klugii*, Butl., 1 ♂ and 1 ♀. Mostly on the strip of ground by the river.

ACRÆINÆ.

ACRÆA VINIDIA, Hewits.

3 ♂. On the strip of ground by the river.

PIERINÆ.

TERIAS SENEGALENSIS, Boisd.

1 ♂, dry or intermediate.

TERACOLUS EUPOMPE, Klug.

2 ♂, 1 ♀; all somewhat "dry."

TERACOLUS GLYCERA, Butl.

1 ♂.

BELENOIS GIDICA, Godt.

Northern form. 1 ♀, dry.

Belenois mesentina, Cram.

1 ♀, dry.

LYCÆNINÆ.

Tarucus theophrastus, Fabr.

1 ♂.

Jan. 16.

A. Between 10 and 11 a.m.

DANAINÆ.

Limnas chrysippus, Linn.

L. chrysippus, Linn., 8 ♂, of which two are small, and several have a faint white powdering on the hind-wing; *alcippus*, Cram., 1 ♂; *klugii*, Butl., 3 ♂, one with faint white powdering on hind-wing.

B. Between 11 and 12 a.m.

DANAINÆ.

Limnas chrysippus, Linn.

L. chrysippus, Linn., 3 ♂, 1 ♀; *alcippus*, Cram., 1 ♀; *klugii*, Butl., 1 ♂ and 1 ♀, the latter with a slight powdering of white on the hind-wings; *dorippus*, Klug., 1 ♂.

ACRÆINÆ.

Acræa encedon, Linn.

1 ♂. This specimen is intermediate between typical *A. encedon* and the form *A. daira*, Godm. & Salv. The apical area is dusky, but the subapical bar is scarcely paler than the general ground-colour. On the various forms of *A. encedon*, and their relation with the corresponding forms of *L. chrysippus*, see Poulton and Marshall in Trans. Ent. Soc. Lond., 1902, pp. 479–484, etc., Plates XIV, XV.

NYMPHALINÆ.

Precis clelia, Cram.

1 ♂; rather small, intensely coloured; no trace of ocelli on upper surface; under-side looks "dry."

Neptis agatha, Cram.

1 ♂.

PIERINÆ.

Terias brigitta, Cram.

1 ♀; wet or intermediate.

TERIAS SENEGALENSIS, Boisd.

2 ♂, dry, one small; 1 ♀ dry or intermediate, also small.

TERACOLUS EUPOMPE, Klug.

1 ♀, rather worn; dry or intermediate.

BELENOIS GIDICA, Godt.

Northern form. 1 ♂, dry or intermediate.

BELENOIS SEVERINA, Cram.

1 ♂, dry or intermediate.

All the captures on Jan. 16 were made in the "garden strip," on a patch of ground 50 yards square.

Jan. 18.

PIERINÆ.

TERACOLUS PROTOMEDIA, Klug.

1 ♂ and 1 ♀, paired.

March 8.

Between 9.30 and 11.30 a.m.

DANAINÆ.

LIMNAS CHRYSIPPUS, Linn.

L. klugii, Butl., 1 ♀.

PIERINÆ.

TERACOLUS EUPOMPE, Klug.

5 ♂, 1 ♀; intermediate and dry.

TERACOLUS EVARNE, Klug.

15 ♂, 1 ♀; all dry, most of them markedly so.

TERACOLUS GLYCERA, Butl.

3 ♂.

LEUCERONIA BUQUETII, Boisd.

1 ♀.

PINACOPTERYX VENATUS, Butl.

1 ♂. This interesting *Pinacopteryx* is represented in the National Collection by only two specimens, both females. The first of these is the type, described and figured by Dr. Butler in Trans. Ent. Soc. Lond., 1871, p.

169; Pl. VII, fig. 7. It was collected on the White Nile by Petherick. The second is Captain Dunn's, and was captured in 1900 on the Bahr-el-Zeraf (Giraffe River, White Nile). The former is much the more heavily marked. Mr. Loat's male corresponds rather with the second specimen, which has more sharply-pointed and narrower wings than the type, and probably belongs to the dry-season phase of the species. The male appears to be hitherto undescribed.

Pinacopteryx venatus, Butl.—*Male.*—General aspect somewhat like that of *P. liliana*, Grose Smith; but smaller, and with fore-wings narrower and more sharply pointed.

Exp. al. 40 mm.

Upper surface:—Wings white. *Fore-wings* with inner third of costa and basal half of cell greyish; a marginal black point at the extremity of the third median branch, and marginal black spots at the extremities of the first and second median, the two radial branches, and the third subcostal. These spots increase in size from behind forwards, and those belonging to the first radial and the subcostal branches become fused, together with a costal spot, into a dark apical patch, in which however the separate constituents are still visible. A thin dark costal streak unites the apical black patch with the basal grey. In the *hind-wing*, the marginal extremity of each vein or branch, except the internal, is marked by a small black spot; the spots belonging to the second subcostal, radial, and second and third median, are somewhat linear, being elongated in the direction of the vein. *Lower surface*:—*Fore-wings* white, slightly greyish along costa and towards base; a small roundish black spot on lower disco-cellular venule. A fuscous mark, wedge-shaped with the base uppermost, passes downwards from the second subcostal near its termination to the space between the first and second radial veins, crossing the common trunk of the third and fourth subcostals; and a large roundish dark spot is situated between the second and third median branches, about half-way between cell and margin. All the veins and their branches, except the submedian, are beset near the margin with a slight powdering of fuscous scales, which at the extremity of each vein or branch become collected into a more or less definite spot. *Hind-wings* creamy white towards base and costa, elsewhere white like the fore-wings; costa edged with pale yellow. A dark oval spot, several times larger than the discoidal spot on the fore-wing, occupies the anterior half of the lower disco-cellular vein, the latter forming its long axis. There is a large fuscous spot on the costa at the termination of the costal vein,

continued posteriorly by another similar spot in the interspace between the subcostals. From the posterior extremity of the latter spot a fuscous band passes across the wing as far as the interspace between the median and submedian veins, half-way across which it terminates. This band is of irregular width and runs generally parallel with the margin of the wing, about half-way between the cell and border. The veins are more richly powdered with fuscous scales than in the fore-wing, and the marginal spots are more prominent, all but that on the submedian being linear, like most of those on the upper surface. The fuscous powdering is more strongly marked on the third median branch than elsewhere, and is continued inwards along two-thirds of the posterior area of the cell as a definite dark streak. There is a rudimentary light fuscous spot in the interspace between the costal vein and the cell, a little internal to the origin of the first subcostal.

In the Hope Collection, Oxford. This form appears to be quite distinct from *P. simana*, Hopff., and *P. liliana*, Grose Smith. On the whole it most resembles the dry-season phase of the latter; but the absence of veining on the upper surface, and the much paler costal margin in *P. venatus* ♂, together with the well-developed apical dark patch and the dark marginal spots, seem to be distinctive.

BELENOIS SEVERINA, Cram.

1 ♂, dry.

A few moths were included in Mr. Loat's collection. They are as follows:—

SYNTOMIDÆ.

SYNTOMIS, sp.

LYMANTRIIDÆ.

DASYCHIRA ACRISIA, Plötz.

PYRALIDÆ.

SURATTHA, sp.

The above were all taken by Captain Bell on board a White Nile steamer between 5° and 6° 30′ N. Lat., Feb.—March, 1902.

ARCTIIDÆ.

DEIOPEIA PULCHELLA, Linn.

2 ♀; near Kaka, April 21, 1901.

GEOMETRIDÆ.

CÆNINA AURIVINA, Butl.

Gondokoro, Jan. 14, 1902.

Further notes on Seasonal Dimorphism, suggested by the above collection.

It will have been noticed that Mr. Loat's specimens fall roughly into three series; the first (*A*) consisting of the butterflies captured near Kaka from April 13 to April 21, 1901; the second (*B*) comprising those collected at Mangala and Gondokoro from Jan. 8 to Jan. 18, 1902; and the third (*C*) being the final batch from Gondokoro caught on March 8, 1902. From the accounts that have been given above of the meteorological conditions prevalent at these periods in the several localities, we should expect all three series to show a preponderance of dry-season forms, though some specimens in series *A* might exhibit the influence of the early rains. The facts are well in accordance with this expectation, but it will be seen that series *B*, though belonging in point of time to the height of the dry season, affords examples of the statement that "in many cases where the existence of seasonal modification has been reasonably presumed, or even actually demonstrated, the seasonal relation is far from being rigidly fixed." *

Thus, the two January specimens of *Terias brigitta* are both wet-season forms; and the same series (*B*) contains several wet-season examples of *Belenois mesentina* and one of *B. severina*. But the most curious instance of apparent seasonal irregularity occurs in the case of *Teracolus daira*. All the specimens of this form caught at Mangala on Jan. 8 and 9 are heavily marked on the upper surface, and would certainly be pronounced at once by most authorities to belong to the wet season. Those on the other hand taken near Kaka on April 21, when the rains had well started, are lightly marked, and bear all the appearance of dry-season examples. Facts of this kind help to emphasise the need that exists for still fuller and more accurate data than we at present possess, if the problems of seasonal dimorphism are to be satisfactorily unravelled.

Persistence of dry-season coloration in the females of seasonally dimorphic species.—Mr. G. A. K. Marshall has lately drawn attention to the fact that in the genus *Acræa* "where the summer males exhibit any particular brilliancy, as *petræa*, *atolmis*, or *nohara*, it is always compensated for by an exceptional dulness on the part of their respective

* Trans. Ent. Soc. Lond., 1902, p. 193.

females." * This dulness of coloration in the wet-season females mentioned is with some hesitation interpreted by Mr. Marshall as being protective in its object. The present is perhaps a fitting opportunity for pointing out that the case of these three *Acræas* seems to bear some relation to a far-reaching principle which has met with less notice than it deserves, and as to the significance of which no suggestion has hitherto been made. The principle I refer to is this:—that the dry-season garb of a seasonally dimorphic butterfly, at least as regards its under-surface, is often far better marked and more persistent in the female than in the male. This is obviously of interest in view of Professor Poulton's interpretation of the cryptic character of dry-season and desert forms.† It would accord with all that we know as to the special importance attaching to the life of the female, and the means that are taken for preserving it, that the more efficient mode of protection, such as on Professor Poulton's hypothesis the dry-season colouring must be, should be more completely and persistently adopted by the sex whose safety from enemies is of such vital moment to the species. The interest of the point perhaps justifies a slight digression, and I propose to give here a few instances which will serve to support the above generalization.

Xanthidia nicippe, Cram. North and Central America. The wet-season female retains on the under-surface a tinge of the dry-season purple.

Ixias pyrene, Linn. India, etc. Here also the wet-season female usually retains the dry-season mottling.

Ixias marianne, Cram. India. The wet-season female is nearly always brown beneath, as are both sexes in the dry season. The under-side of the wet-season male is yellow.

Catopsilia pomona, Fabr. Oriental and Australian Region. In the wet-season form (*C. crocale*, Cram.)‡ the female often retains in some degree the dry-season

* Trans. Ent. Soc. Lond., 1902, pp. 433, 434. It is hardly necessary to remark that the peculiar need for protection experienced by the female sex was first pointed out by Mr. Wallace. Some of the provisions towards this end were recognized by him as cryptic (as in many birds); others were supposed to be pseudaposematic. It is now known that synaposematism may also play an important part in the special protection enjoyed by female insects. See Trans. Ent. Soc. Lond., 1902, pp. 466, 467, *ibique cit.*

† *Ibid.*, pp. 431–433, etc. ‡ *Ibid.*, p. 109.

ocellation and other characters, though there is an extreme *crocale*-form in which they are lost. The "dry-season" form *C. catilla*, Cram., which is probably strongly cryptic, belongs solely to the female sex.

Pyrisitia proterpia, Fabr. Central and South America. This is a wet-season form of which there is every reason to suppose that *P. gundlachia*, Poey, is the dry-season modification. The seasonal changes of this species afford an interesting parallel with those in the genus *Precis* which have lately been so completely dealt with by Mr. Marshall and Professor Poulton.* The cryptic under-side of the dry phase is rendered still more leaf-like by the uncination of the fore-wing and the prolongation of the hind-wing into a tail-like process, as in *Precis archesia* and *P. antilope*. This applies to both sexes, but is better marked in the female, as can be seen in the specimens figured (Pl. VII, figs. 1–4). In the wet season both sexes have lost their leaf-like contour, but the female remains of a duller hue than the male. A somewhat similar case is that of *Teracolus auxo*, Luc., both sexes of which in the dry-season form (*T. topha*, Wallgr., or *T. keiskamma*, Trim.) often show a slight uncination in the fore-wing, though in this species "tails" are not developed. The cryptic colouring of the dry-season under-side is to some extent retained by the wet-season female (Pl. VII, figs. 5–8).

This latter is a common feature in the African and Indian genus *Teracolus*. *T. phlegyas*, Butl., *T. ione*, Godt., *T. regina*, Trim., *T. danae*, Fabr., *T. eucharis*, Fabr., *T. eris*, Klug, are all cases in point, for in each of them the wet-season female shows beneath at least a trace of the characteristic dry-season tinge. Even where this does not occur, the under-side of the female in the wet season is usually more cryptic than that of the male, as may be seen, *e. g.*, in *T. omphale*, Godt., and *T. achine*, Cram.

In *Teracolus phisadia*, Godt., and *T. puellaris*, Butl. (Pl. VII, figs. 9–12, 13–16) the principle receives perhaps its highest development. The female of the latter species retains its cryptic sand-coloured under-side at all seasons, the under-side of the male in the wet season being bright yellow. In the former species the female is always, on the under-side, a cryptic, sand-coloured, "dry-season" form; the male in the dry season may be similarly cryptic, or

* See Trans. Ent. Soc. Lond., 1902, pp. 424 *et sequ.*, Pl. XII, XIII.

may possess, as it always does in the wet season, a bright yellow under-surface, like that of *T. puellaris.*

Simultaneous occurrence of diverse seasonal forms.— Attention has frequently been called to the fact that at Aden, and probably in other arid districts, "dry," "wet" and "intermediate" forms may all be found on the wing together. Colonel Yerbury remarks with reference to Aden that "seasonal dimorphism does not seem to occur to any extent in the neighbourhood; though it may possibly do so in the case of *Teracolus calais* and *dynamene.*" * We may take this to mean, not necessarily that the different phases usually associated with different times of year are never found at Aden (for the occurrence of some of them at that spot is well attested), but that they do not there undergo, as in many places, a regular alternation in correspondence with the change of season. On the exceptional case of *T. calais* Colonel Yerbury remarks further as follows:—"The year 1883 was very wet, heavy rain having fallen in May, consequently in July a large number of Butterflies appeared—among others, a very brightly-coloured form of *T. calais* (all, I believe, females however): this may point to *T. calais* being the rainy-season form and *T. dynamene* the dry. I never met with this unusually brightly-coloured form in after years."

It may be noted in this record that at least a month must have elapsed between the heavy rain and its supposed effect on the numbers and aspect of the butterfly fauna; this seems to point (like the facts recounted by Poulton for the genus *Precis* †) to the larval being the susceptible stage. On the other hand, the effect of rain may in some instances be less remote, as appears from another statement by Colonel Yerbury,‡ as follows:—"Few passengers (for the matter of that, no great number of the residents) have any idea of the effect on 'the barren rocks of Aden' of a few heavy showers; how almost immediately, as if by magic, vegetation springs up in every ravine and watercourse, accompanied by a tolerably abundant insect fauna." In the discussion that followed the reading of the author's paper on "Seasonal Dimorphism" (Proc. Ent. Soc. Lond., March 19, 1902), Colonel Yerbury further observed that "a temporary rainfall in a dry season in dry

* Proc. Zool. Soc., 1896, p. 257.
† Trans. Ent. Soc. Lond., 1902, p. 457, etc.
‡ Journal Bombay Nat. Hist. Soc., vol. vii, 1892, p. 208.

places had a marvellous effect in producing intermediate and wet-season forms." That the meteorological conditions prevailing at or about the time of emergence may in some cases influence the aspect of a brood appears also from many experiments of Mr. Merrifield, especially those with *Selenia tetralunaria*, Hufn., by which it was conclusively proved that for certain effects of seasonal coloration "the later days of the pupal period were especially important."* It is worthy of notice that the rule which obtains in *Precis*, as to the superiority in size of the dry-season form, is not of universal application. Mr. Marshall rightly points out † that Mr. Barker's statement as to the generally smaller size of dry-season forms is too sweeping; but there can be no doubt that in many instances the statement in question holds good. This is perhaps especially the case among the *Pierinæ*, concerning the Indian species of which group Captain Watson says:—"In all genera the dry-season forms are as a rule smaller than the rainy-season forms." ‡ In other instances there appears to be no constant difference.

The superiority in bulk of the dry-season form in certain species of *Precis*, resting as it does upon the result of a careful series of weighings of the two forms by Professor Poulton, is quite beyond doubt; but it may be well to remember that in other instances a difference in size may sometimes be more apparent than real. This may possibly be the case with the broods mentioned by Mr. Merrifield in Trans. Ent. Soc. Lond., 1892, pp. 40, 41, on which, together with a similar experience of Weismann's, he bases a guarded opinion that both size and shape may be individually altered during the pupal state. This is a point that no doubt calls for further investigation, but in the meantime it will probably be allowed that, whatever may be the case with *Precis*, there is reason to believe that the seasonal aspect is not in all instances determined before the assumption of the pupal condition. It is, as has just been remarked, by no means certain that the differences in size noticed by Mr. Merrifield were as real as those in *Precis*, but, whether they were so or not, they could not under the circumstances have originated in the larval state.§

* Trans. Ent. Soc. Lond., 1891, pp. 155–167.
† *Ibid.*, 1896, p. 551; 1895, p. 413.
‡ Journal Bombay Nat. Hist. Soc., vol. viii, 1894, p. 492.
§ In considering the case of *Precis* it should not be forgotten that

The foregoing may perhaps help us towards an explanation of the well-attested facts relating to the simultaneous occurrence of seasonal forms in generally dry localities like Aden. A feature in Colonel Yerbury's graphic description of a temporary rainfall and its effects is the rapid springing-up of vegetation and the accompanying increase of insect life. As Professor Poulton has shown, these are the exact conditions which allow of the assumption of aposematic colouring and habits in exchange for those of a cryptic character. Now if we assume, as it seems from Colonel Yerbury's observations we may, that many of the Aden species are in a condition to respond almost immediately to a sudden access of moisture, the occurrence of the more conspicuous "wet-season" contemporaneously with the cryptic "dry-season" forms receives some explanation. Where there is a regular alternation of long periods of drought and humidity, the seasonal phases of the insect fauna fall into a corresponding regularity of succession; but where, as at Aden, a general state of aridity is liable to be occasionally disturbed by heavy rainfalls of a temporary character, the intermittent meteorological conditions are apt, we may suppose, to be reflected in a similar intermixture of aposematic and cryptic forms of insect life. It would not be difficult for residents in such localities to test the suggestion here offered.*

Note on Teracolus daira *and* T. evagore, *Klug.*—Dr. Butler, in his "Revision of the Genus *Teracolus*" (Ann. Mag. Nat. Hist., 1897), distinguishes *Teracolus yerburii*,

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the usual rule as to the superiority in weight of the *sesamus* form did not obtain in the instance of Mr. Marshall's *P. sesamus* and *P. natalensis* bred from two eggs laid by the same mother. The weights as determined by Professor Poulton (Trans. Ent. Soc. Lond., 1902, p. 451) show that in this case the *natalensis* form was the heavier of the two. Whatever then may have been the influence which caused the diversity between the two offspring, it did not find expression in any increased bulk of the *sesamus* larva. It should also be borne in mind that the larval conditions of the first dry- or wet-season brood will probably differ from those of the second and subsequent broods (should there be more than one) of the same season.

* See Mr. G. A. K. Marshall's account of the simultaneous flight of different seasonal phases during an abnormal season in Mashonaland (Ann. Mag. Nat. Hist., 1901, vol. ii, p. 402), and compare the discussion of the succession of seasonal phases in *Precis* by Professor Poulton and Mr. Marshall in Trans. Ent. Soc. Lond., 1902, pp. 443–449.

Swinh., from *T. daira*, Klug. Specimens of *T. yerburii*, however, collected at Lahej, Arabia, by Captain Nurse and determined by Colonel Swinhoe, who presented them to the Hope Collection, correspond closely with *T. daira* as figured by Klug. The locality given by Klug for *T. daira* being "Arabia felix," it seems improbable that *T. yerburii* can be more than a synonym for *T. daira*, though Mr. G. A. K. Marshall and Professor Aurivillius agree with Dr. Butler in keeping them distinct. *T. evagore*, Klug, which is no doubt identical with *T. saxeus*, Swinh., is regarded by Butler as the dry-season form of *T. yerburii*. Whether *T. glycera*, Butl., be considered as a species, or as a mere local race of *T. antigone*, there is no doubt that it is barely, or perhaps not at all, separable from *T. evagore*. Hence, if *T. evagore* be the dry-season form of the Arabian *T. yerburii* (i.e. *T. daira*), *T. glycera* should be the dry-season phase of the form of *T. daira* occurring in the same locality with itself, viz. on the White Nile. When, however, Captain Dunn's collection arrived from the Bahr-el-Zeraf branch of that river, it was found to contain *T. glycera* in different seasonal phases, all of which were quite distinct from the specimens of *T. daira* captured in the same district. In dealing with Captain Dunn's collection Dr. Butler * makes no attempt to unite these two forms, and the examination of Mr. Loat's specimens convinces me that he is right in keeping them distinct. But this seems to carry with it a similar conclusion with regard to the Arabian *T. evagore*, which, if the foregoing be correct, cannot be considered as the dry-season form of "*T. yerburii*" or *T. daira*. The only piece of evidence that seems to make against this view is the supposed breeding of *T. yerburii* and *T. evagore* by Captain Nurse from similar larvæ. Since writing the note in Trans. Ent. Soc. Lond., 1902, p. 195, I have been strongly disposed to think that the inference drawn from Captain Nurse's account needed confirmation, and I was accordingly quite prepared to agree with Colonel Yerbury when I found him urging in Miss Sharpe's very useful "Monograph of the Genus *Teracolus*" (p. 137) that "too much stress should not be laid on the fact that Captain Nurse bred a specimen of *T. evagore* from a caterpillar taken with the larvæ of *T. yerburii*. . . . *T. evagore* and *T. yerburii* may be seasonal forms [of each other], but

* Proc. Zool. Soc., 1901, pp. 25, 26.

at present the fact is not proved." Mr. Loat's collection appears to me to bring positive evidence against the view of their identity, and from the above considerations I think there can be little doubt that Mr. G. A. K. Marshall is right in entirely dissociating *T. evagore* in all its forms (including *T. nouna*, Luc.) from *T. yerburii* (i.e. *T. daira*).

I am indebted to Professor Poulton, F.R.S., for the opportunity of working out Mr. Loat's interesting collection, and also for the Plate which accompanies this paper.

Explanation of Plate VII.

Fig. 1. *Pyrisitia proterpia*, Fabr., wet-season form, male.
" 2. " " " " female.
" 3. *P. proterpia*, dry-season form (*P. gundlachia*, Poey), male.
" 4. " " female.

The *wet-season* ♀ (Fig. 2) is less brightly coloured than the corresponding ♂ (Fig. 1).

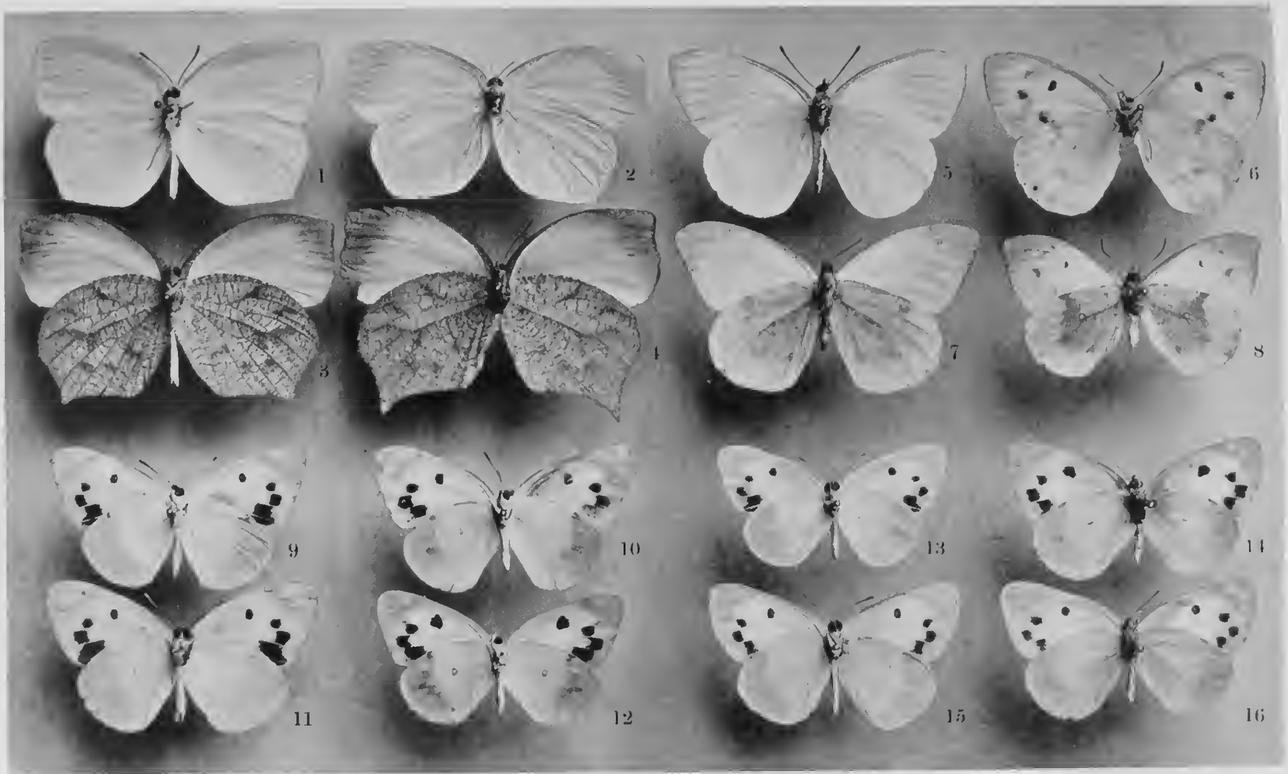
In the *dry season* both sexes adopt cryptic colouring on the under-side, accompanied by leaf-like shaping of the fore- and hind-wing, more pronounced in the ♀ (Fig. 4) than in the ♂ (Fig. 3).

Fig. 5. *Teracolus auxo*, Lucas, wet-season form, male.
" 6. " " " " female.
" 7. *T. auxo*, dry-season form (*T. topha*, Wallgrn. = *T. keiskamma*, Trimen), male.
" 8. " " female.

The *wet-season* ♀ (Fig. 6) retains some of the colouring of the dry-season form.

Both sexes in the *dry season* (Figs. 7 and 8) show slight uncination of the fore-wing.

The specimens represented in Figs. 6 and 8 were bred by Mr. Mansel Weale, and belong to the series referred to in Trans. Ent. Soc., Lond., 1902, p. 201.



Trans. Ent. Soc. Lond., 1903. Pl. VII.

Dixey. André & Sleigh, Limited.

All the figures are about $\frac{5}{9}$ of the natural size.

Sexual and Seasonal Dimorphism in Pierinæ.

FIG. 9. *Teracolus phisadia*, Godt., wet-season form, male.
" 10. " " " " female.
" 11. *T. phisadia*, dry-season form, male.
" 12. " " female.

The under-side of the hind-wing in the ♂ (Figs. 9 and 11) is generally bright yellow, especially in the *wet season*.

The under-side of the hind-wing in the ♀ (Figs. 10 and 12) is sand-coloured at *all* seasons.

FIG. 13. *Teracolus puellaris*, Butl., wet-season form, male.
" 14. " " " " female.
" 15. *T. puellaris*, dry-season form (*T. ochreipennis*, Butl., = *T. rorus*, Swinh.), male.
" 16. " " female.

The under-side of the ♂ is bright yellow in the *wet season* (Fig. 13), sand-coloured in the *dry* (Fig. 15).

The under-side of the ♀ is sand-coloured at *all* seasons.

See pp. 157, 158 above. In all the figures, the under-side alone is represented.

It should be borne in mind that in the absence of colour it is impossible to represent the tone-values with complete accuracy. The difference, *e.g.*, between the clear yellow of Figs. 9, 13, and the sandy tint of Figs. 10, 14, is far more conspicuous in nature than in the Plate.

EXTRACT FROM THE PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY OF LONDON

(April 29, 1903.)

Dr. Frederick A. Dixey, M.A., M.D., read a paper, illustrated by lantern slides, "On Lepidoptera from the White Nile, collected by Mr. W. L. S. Loat, F.Z.S.; with further Notes on Seasonal Dimorphism in Butterflies." He said that the collection of butterflies which had been made at intervals by Mr. Loat during his tenure of office under the Egyptian Government was of special interest on account of the accurate data which accompanied the specimens. Mr. Loat's collecting grounds were in the neighbourhood of Kaka, about 11° N. lat.; and of Gondokoro, about 6° further south. The meteorological conditions at the time of collecting were generally those of the dry season, though at Kaka the rains were just beginning. Most of the examples of seasonally dimorphic species belonged to the "dry-season" phase; but there were some curious exceptions. Perhaps the most remarkable of these was *Teracolus daira*, Klug, specimens of which caught in January, during the height of the dry season, were of the full "wet-season" colouring; while some of those taken at the beginning of the rains were much "drier." The large proportion of *Pierinæ* to the whole number of captures was noticeable, as also was the general likeness of the whole assemblage to the butterfly fauna of Aden; the different forms of *L. chrysippus*, for example, were found by Mr. Loat all flying together at the same spot, just as is the case at Aden. The collection brought to light no new species; it contained, however, a single example of the male of *Pinacopteryx venatus*, Butl., of which only two

specimens, including the type, both females, have hitherto been known to science.

Mr. Loat's series did not seem to favour the opinion that had been held that *Teracolus evagore*, as described and figured by Klug, was the dry-season form of *T. yerburii*, Swinh. It appeared from this and other evidence that Mr. G. A. K. Marshall was right in dissociating the two forms. The weakness of the reasons given for the contrary view had lately been pointed out by Col. Yerbury.

With regard to the general question of Seasonal Dimorphism, a point that deserved notice was the greater intensity and greater persistence of the cryptic dry-season coloration of the under-surface, which often characterizes the female sex. This might be illustrated from among Mr. Loat's specimens; but the principle was of wide application, and was operative in both hemispheres. In the genus *Teracolus* especially, the "wet-season" female often retained some of the "dry-season" garb, and in certain cases (as in *T. puellaris* and *T. phisadia*) the female could scarcely be said to have a "wet-season" phase at all. The significance of these facts lay no doubt in the special need for protection experienced by the female sex. Prof. Poulton had lately given strong grounds for believing that on the whole concealment was a more efficacious means of defence for moderately distasteful forms than the display of warning colours, especially when the pursuit was keen; and the instances here adduced seemed to show that it might in some cases be of advantage for the female of a given species to remain cryptic in the wet season, even though the male should assume brighter colours with the advent of a more copious supply of insect life. An interesting parallel with the seasonal changes in *Precis antilope* and *P. archesia*, so carefully worked out by Mr. Marshall and Prof. Poulton, was furnished by the Central and South-American *Pyrisitia proterpia*, Fabr. (a Pierine form allied to *Terias*), with what is doubtless its dry-season phase, *P. gundlachia*, Poey. Here, as in *Precis*, the dead-leaf appearance of the under-surface in the dry-season form is enhanced by the falcation of the forewings and the development of "tails." These changes of shape are found in the *gundlachia* form of both sexes, but are intensified in

the female; in the wet-season or *proterpia* form they are retained by neither sex, but the under-surface of the female is duller than that of the male.

The simultaneous occurrence in generally dry localities, such as Aden, of forms which in other places are associated with contrasting seasons, was not easy to explain. Prof. Poulton had shown that in several species of *Precis* the dry-season form was larger than the wet, and had on that fact founded the inference that the dry-season form must have been predetermined in the larval stage. But there was reason to believe that in many genera, and perhaps even occasionally in *Precis*, the assumption of the characteristic seasonal garb was not determined until a later period—in some cases, the last few days before emergence from the pupa. If it might be assumed that the Aden species in question were in a state so sensitive to meteorological conditions as to respond almost immediately to a few heavy showers, such as were reported to fall there not unusually from January to May, the intermixture of "wet" and "dry-season," which in many cases meant an intermixture of aposematic and cryptic forms, might possibly be accounted for. This suggestion could only be verified by observers on the spot.

ENTOMOLOGICAL SOCIETY OF LONDON.

May 6th, 1903.

Professor POULTON showed a specimen of *Polygonia* (*Grapta*) *C-album* in the attitude of prolonged repose, together with specimens of *Anæa moeris* set in different ways to illustrate its probable resting position. Upon these specimens he read the following notes :—

"Many years ago I came to a conclusion as to the probable meaning of the 'C' or 'comma' on the under surface of the hind-wings in butterflies belonging to the genus *Polygonia* (*Grapta*). I believe that it represents, in bright, strongly-reflecting 'body-colour,' the light shining through a semi-circular rent in a fragment of dead leaf,—the rent produced when a little segment of leaf has broken away along a curved line, but still remains connected with the rest across the chord of the arc. Unless such a segment remains precisely in the plane of the leaf, light may pass through a curved and often a semi-circular slit-like window. Such curved cracks are extremely common in old weather-beaten dead leaves. They are probably produced by drying and shrinkage after much wetting and some decay.

"On April 23rd last I had the opportunity of testing how far the whole attitude of *Polygonia C-album*, during profound repose, is consistent with the interpretation suggested above. By a curious coincidence I had been speaking of the differences between temporary and prolonged resting attitudes in butterflies, at the meeting of the Entomological Society of France on the evening of April 22nd, and the very next morning saw for the first time in my life the position of this species during complete repose. The day was excessively cold for this time of the year, and the butterfly was hanging perfectly torpid from the horizontal rail of a wood fence in a street at Passy. Several excellent but very small photographs were taken with my daughter's camera: enlargements have been made, and from these the actual specimen has been set and photographs

of the natural size taken by Mr. Robinson in the Oxford University Museum.

"The specimen which is now exhibited affixed to a piece of stick in precisely the same manner in which it hung from the rail, shows that the two anterior wings are held so far forward that a deep wedge-shaped notch appears between them and the hind-wings. On each side of this notch the well-known ragged outline of the wings is extremely distinct. The two posterior pairs of legs by which the butterfly clings to the supporting surface are light-brown in colour and unexpectedly conspicuous. The antennæ are concealed, and the contour of the head does not break that of the costal margin of the anterior wings so as to interfere in any way with the general effect. The whole appearance is consistent with a single interpretation—concealment effected by resemblance to a weather-beaten fragment of dead leaf, deeply notched and ragged, and hanging by two denuded fibro-vascular 'veins' standing out far beyond one of the edges. The kind of injury suggested by the 'comma' only adds another convincing detail to a perfectly harmonious cryptic effect.

"It is interesting to compare this mode of concealment with that which is far commoner in Nymphaline genera (*Kallima*, *Doleschallia*, *Anæa*, *Precis*, etc.), viz. the resemblance not to a fragment but an entire dead leaf, with midrib and suggestion of lateral oblique venation. In this latter form of disguise, holes are frequently suggested in the apparent leaf, either by opaque 'body-colour' as in *Doleschallia*, by transparent windows as in *Kallima*, or by actual discontinuity, as is probably the case in certain species of *Anæa* in which the deeply-cut bay in the inner margin of the fore-wing may be converted into the likeness of a hole by closure along its open side by the costal margin of the hind-wing, in the manner indicated in one of the specimens exhibited. In certain parts of the under surface of *Kallima* a hole is suggested by 'body-colour,' in other parts by transparency, and the latter is undoubtedly the more recent and more highly-specialized method; for when the transparent window is examined under the microscope scattered opaque white scales can still be seen in abundance over its surface, not thickly placed so as to prevent the passage of light, but

witnesses to an earlier and less perfect representation of light shining through a hole.

"It is interesting to note that the holes represented in these apparent dead leaves seem to have been produced by gnawing, whereas in the leaf-fragment suggested by *C-album* the forces of the inorganic environment, which by their prolonged action have produced the wear and tear of the margin, have also been responsible for the more centrally-placed discontinuity. Comparing various species of the genus *Polygonia* (*Grapta*), it is seen that the curved **C**-like window occurs in several; in some the suggested rent is **V**-like, while occasionally the mark appears to represent a hole of a reniform shape."

Professor POULTON also exhibited a pair of *Hypolimnas misippus* taken "in coitu" on Feb. 3rd, 1903, by Mr. Horace A. Byatt, B.A. (Lincoln College, Oxford), near his highland home at a height of 4500–5000 feet, in Dedza, Central Angoniland, British Central Africa. The specimens are remarkable in that the female is excessively worn and old, far more so than the male. Such an observation tends towards the conclusion that pairing occurs more than once in the life of an individual of this species.

Mr. BYATT also writes (Feb. 15th, 1903) concerning the species—"Close round my house *H. misippus* is in vast numbers just now, but other species are not very numerous. You will see that at Dedza *L. chrysippus* is quite rare—at least at this season. I have sent you only two, I think, and my eyes are always open for it." This observation of relative abundance certainly suggests the Müllerian rather than the Batesian interpretation of the mimicry of the former for the latter species; although quite near to Dedza the proportions may be entirely different. The following passage shows how rapidly Mr. Byatt can pass from one kind of area into another. "You must understand that I have two distinct climates to work in. I am about 4500 to 5000 feet up—the top of Dedza is 7000—and I drop straight down into what is really tropical Africa on the lake level: tropical foliage, swamp, damp atmosphere and intense heat. This station might be in S. Africa—say the Orange River Colony. Consequently Lepidoptera are widely different: in this open country ey are fewer and more sober

in colouring; down below they are plentiful, more varied, larger and more gaily coloured. *Precis* so far seems to be below 3000 feet, and extremely rare up here."

The observations of another friend further to the north in Africa also show the great abundance of *H. misippus* and how far it is from occupying the subordinate numerical position assigned to mimics by the late H. W. Bates. Between January 20th and 25th of the present year Mr. C. A. Wiggins captured at Kisumu, near the terminus of the Uganda line, on the N.E. shore of Lake Victoria Nyanza, the following specimens of this model and mimic:—

Limnas chrysippus.	*Hypolimnas misippus* (females).
Type-form 10.	Type-form 27.
klugii-form 20.	*inaria*-form 16.

And again at the end of January and the beginning of February:—

L. chrysippus.	*H. misippus* (females).
Type-form 73.	Type-form 18.
klugii-form 85.	*inaria*-form 15.

These results are roughly compiled from the unset specimens, but no serious modification of the proportions is to be expected. Mr. Wiggins' very large and interesting series of captures, bearing upon many bionomic problems of the highest interest, are now being studied in the Hope Department by Mr. S. A. Neave, B.A., of Magdalen College.

EXTRACT FROM THE PROCEEDINGS

OF THE

ENTOMOLOGICAL SOCIETY OF LONDON

(June 3, 1903.)

The President exhibited the dry form of *Precis actia* bred by Mr. Guy A. K. Marshall from an egg laid by a female of the wet form. The parent was captured by Mr. Marshall at Salisbury, Mashonaland (5000 ft.), on February 14th, 1903: the egg was laid on the following day. It hatched February 20th, the larva pupated March 16th, the perfect insect, a male, emerged March 28th. The differences between these two forms are as astonishing as those between the two phases of *Precis antilope*, bred, the dry from the wet, by Mr. Marshall last year (Trans. Ent. Soc. London, 1902, pp. 418–20). In fact, upon the upper surface of the wings the differences are much greater than in this latter species, the dominant colour upon the black background of the dry form of *actia* being blue, as it is in the dry form of *sesamus*, while the red is of so deep a shade as to be sombre and inconspicuous. In the wet form these blue markings are only represented by marginal, submarginal, and apical traces, while the dull red becomes a bright and vivid reddish-brown, which forms a startling contrast with the background and the row of black spots which crosses both wings. Within these spots, in the position of the chief blue band of the dry form, the reddish-brown band of the wet form passes into a brilliant pearly white in the female, into a pale reddish-brown in the male,—forming in each case a startling contrast with the nearly black basal half of both wings against which it terminates abruptly. Intermediate forms are probably much commoner than in *P. sesamus*. In one dry male out of four in the Hope Department, the chief blue band is in large part replaced by an intrusion of dull red. The extraordinary differences in shape

are the same as those between the two forms of *P. antilope* (compare Fig. 3 on Plate XII of Trans. Ent. Soc. Lond., 1902, with Figs. 3*a* and 3*b*) and much greater than those between the forms of *P. sesamus* (compare Fig. 1 with 1*a* or 2 with 2*a* on the same plate). In the dry phases of *actia* and *antilope* the hooked tip of the fore-wing is even more recurved than in that of *sesamus*, while the prolongation of the anal angle of the hind-wing which is so marked a character in the two former is wanting in the latter species. These characteristic features in the contour of the wings in the dry *antilope* and *actia* are related to the beautiful and detailed resemblance of their under-sides to dead leaves, while the greenish-black underside of the dry *sesamus* is well concealed by a general harmony with the dark shady environment which it seeks for prolonged rest, rather than by any detailed special protective resemblance. Hence the necessity for a profound modification of shape is far less imperative in this latter. It has been pointed out that the upper-side differences between the two phases of *actia* are greater than in *antilope*. As regards their under-sides the reverse is the case, because this surface is so much less conspicuous in the wet phase of the former when compared with that of the latter species. It is, however, very far from being cryptic, attaining nearly the same degree of conspicuousness as *Precis trimeni* which Mr. Marshall considers to be another of the wet forms of *antilope* (*l. c.* pp. 419, 420). The representation of a dead leaf by the underside of the dry *actia* is slightly more elaborate than in *antilope*. Both species have an equally beautiful mid-rib-like stripe, but the former alone possesses the representation of two holes, the posterior minute, near the tip of the simulated leaf—due to white semi-transparent spots. Equally elaborate detail is seen in *P. cuama*, of which *P. trimeni* is the wet form. In Mr. Marshall's opinion, however, *P. antilope* and *P. cuama* are two dissimilar dry forms and *simia* and *trimeni* two dissimilar wet forms of a single species. It is much to be hoped that the point will soon be settled by breeding.

Mr. Marshall is to be warmly congratulated on this third South African species of the genus *Precis*, in which he has produced incontrovertible evidence of the specific identity

of forms widely separated in colours, patterns, shape, relation of upper- to under-side, etc., and even instinct, including the selection of a particular type of country.

The PRESIDENT also showed a small series of ants, part of a much larger collection made by the late W. J. Burchell in Brazil between the years 1825 and 1830. They were obtained with his other vast zoological and botanical collections at Rio or its neighbourhood, or in the course of the long journey from Santos to Pará. Considering their great age the specimens were wonderfully well preserved and are accompanied by remarkably exact and detailed data, and, in many cases, interesting notes on habits, instincts, etc. Hardly anything in the whole of the zoological material, all of which was presented by Miss Anna Burchell to the University of Oxford in 1865, has as yet been published. Arrangements were now being made to ensure that these interesting results may, with as little delay as possible, be given to the scientific world.

The PRESIDENT, Professor E. B. POULTON, gave a summary of his paper on the effect of lichen-covered bark, etc., upon certain Lepidopterous larvæ. He explained that these results were now being brought forward about ten years after the experiments had been begun. The delay was to be explained by the disorganization of the library and papers of the Hope Department during the building operations in 1894. As a result the notes of the Professor and Mr. Holland, as well as the beautiful water-colour drawings made by Mr. P. J. Bayzand, were mislaid, and when everything necessary had been recovered the press of other work for a time prevented this memoir from being undertaken.

The chief object of the investigation was to test the efficiency of lichen-covered bark as a stimulus for the production of a lichen-like appearance in certain larvæ. It was found that *Gastropacha quercifolia* was highly sensitive to such a stimulus up to the beginning of hybernation, but that during and after hybernation, all such susceptibility entirely ceased. The larvæ were also sensitive, during the same period, to brown and black bark, which caused the appearance of corresponding tints. In all experiments the food made use of was the same, viz. the leaves of the hawthorn.

Odontopera bidentata was also sensitive to the same surroundings, lichen in the environment producing the well-known green patches on the dorsal surface.

The rigid restriction of the sensitive period to the earlier part of larval life in the case of *quercifolia* suggested a set of transference experiments on the highly sensitive larva of *Amphidasis betularia*, carried out in the summer of 1896. The result was to prove that this species remains sensitive, at least to the strongest stimuli, viz. those provided by dark bark, for nearly the whole of larval life.

XVIII. *Experiments in* 1893, 1894, *and* 1896 *upon the colour-relation between lepidopterous larvæ and their surroundings, and especially the effect of lichen-covered bark upon* Odontopera bidentata, Gastropacha quercifolia, etc. By Edward B. Poulton, D.Sc., M.A., LL.D. (Princeton), F.R.S., etc., Hope Professor of Zoology in the University of Oxford, Fellow of Jesus College, Oxford.

[Read June 3rd, 1903.]

Plates XVI, XVII, and XVIII.

The circumstances under which the experiments recorded in the present memoir were undertaken, afford a good example of the stimulus and encouragement to work rendered possible by that mutual intercourse and exchange of experience and ideas which are promoted by meetings of scientific societies.

In the year 1892 I conducted an extensive series of experiments upon the adjustment of the colours of the larvæ of *Amphidasis betularia* to those of their environment (Trans. Ent. Soc. Lond., 1892, pp. 337–369). Living examples of the chief results obtained were shown at the meeting of Section D of the British Association at Edinburgh, on August 9th (Report of the 1892 Meeting, p. 786, where however the word "pupæ" is erroneously printed instead of "larvæ"). After the larvæ had been exhibited, Dr. Stacey Wilson, of Birmingham, asked if I had tried the effect of lichen-covered bark. Dr. Wilson stated that he had once beaten the larva from a food-plant with twigs covered by lichen, and that its appearance was entirely different from that usually borne by *betularia*. He looked upon it, in fact, as the larva of some other species, and was only convinced by breeding the moth (Trans. Ent. Soc. Lond., 1892, p. 360). The idea of making use of an environment of lichen-covered bark had not occurred to me, and I determined to try

the experiment on this and other suitable larvæ on the first opportunity.

I propose to state the results of these experiments forthwith, referring to the plates which accompany the paper. Hence it will be possible to gather the conclusions by looking at the few first pages, while those who desire to study the evidence in detail will find it recorded in the later part of the memoir.

The first larva which appeared suitable for the purpose was *Odontopera bidentata*, and Mr. G. T. Porritt very kindly consented to look out for eggs. Mr. Porritt had himself suggested to me that the larva would probably prove to be especially suitable for the purpose of this enquiry, and he wrote on May 9th, "the larva varies so very much in a wild state according to its food, that I fancy it will form an interesting subject for your experiments." * On May 9th, 1893, he kindly sent me from Huddersfield a batch laid by a single female, and, on June 13th, a second consignment laid by two females, from Sledmere on the Yorkshire Wolds. The first set afforded the material of Experiments I to IX (including VA) described in this paper. The second mixed set formed the subject of Experiments X to XVIII. The chief results of both experiments will be gathered by a glance at Plate XVI, in which figs. 1 to 5 represent larvæ from the first set of eggs, figs. 6 to 11 larvæ from the second set. At the same time results like those shown in the former figures were produced in larvæ of the second set and like those in the latter figures, in larvæ of the first set.

The detailed account of the experiments shows the number of days which elapsed before the influence of each environment became visible, and the time which was necessary in order to produce the full effect. A very large number of records proves that the larvæ, in the great majority of cases, rested by day upon the object which

* Dr. T. A. Chapman wrote to me (June 14, 1903), concerning the forms and habits of *bidentata*:—"About forty years ago, I took three or four beautifully green latticed larvæ off the lichen-covered trunk of an old alder-tree in Glen Messen (Argyleshire). They were quite new to me, and though very like (of course) *bidentata*, I thought they must be something else, a lichen-feeder. When they produced *bidentata*, I got no further than wondering whether *bidentata* was sometimes a lichen-feeder. I remember well their resting-place was near the ground, many feet from any leaves,—as long a journey for feeding as the larva of *Aprilina* makes."

they afterwards came to resemble. This, however, is probably not the case in the earliest stages, when the larvæ doubtless rest on the leaves and stalks.

The extreme sensitiveness of this larva is clearly shown by a glance at Plate XVI. The four first figures indicate a power of adjustment about equal to that of the most sensitive larva hitherto known, *Amphidasis betularia* (compare Trans. Ent. Soc. Lond., 1892, Plate XIV). The effect of green leaves and shoots, shown in fig. 5, is however very inferior to that produced upon *betularia*, which becomes bright green in this environment. The effect of green leaves alone upon *bidentata* is the same as that observed in many other larvæ, Noctuæ as well as Geometræ, viz. the reduction of the brown ground-colour to a very pale tint which would be far less conspicuous than the more ordinary appearance. The contrast between the results of an effective environment of green, and nothing but green, as shown in fig. 5, and of green scattered over a brown background of bark, as shown in figs. 6 to 11, is very striking, and suggests renewed experiments with an artificial arrangement of combined colours. Another interesting fact, suggesting the restriction of larval susceptibility to the *immediate* surface upon which the resting periods are passed, is the entire absence of any effects traceable to the green leaves of the food-plant when present with the other forms of environment employed in these experiments. The complex nature of the result produced is well seen in the oblique white lateral marks which are found in larvæ with the green lichen-like patches (figs. 6, 9), and probably assist in the general effect by breaking up the larval surface. The green markings are developed in the vicinity of and include the projecting ridges, etc.—a fact which is of obvious significance in promoting the resemblance to small scattered masses of lichen. The various kinds of lichen made use of did not produce corresponding effects.* Thus the green dorsal patches shown on the larvæ which had been exposed to orange lichen (figs. 8, 9) did not differ in any marked degree from those in which a green lichen had been chosen. It is by no means

* My friend Professor S. H. Vines, F.R.S., has very kindly given me the probable names of the lichens made use of. They will be found in the detailed account of the experiments, and in the description of Plates XVI to XVIII. The names could not be given with certainty because the specimens themselves had been lost.

unlikely, however, that under entirely normal conditions special detailed adjustments of this kind may be brought about. With regard to the sensitiveness to lichen, *bidentata* appears to be as superior to *betularia*, as it is inferior to the latter larva in sensitiveness to green leaves, so that the two species may be considered about equal in the power of colour adjustment. It is interesting to observe that dark purplish-brown twigs with white spots, although producing lighter larvæ than those upon unspotted but otherwise similar twigs (compare figs. 4 and 3), did not lead to the appearance of white marks upon the larvæ (fig. 4).

Dr. Stacey Wilson's experience led me to try the same experiments with an environment of lichen in the case of *A. betularia*. My friend Mr. Arthur Sidgwick kindly gave me a small batch of eggs in the summer of 1893, and the fourteen young larvæ which hatched from them were subjected, together with *bidentata*, to this form of environment, in Experiments XII to XV. It will be seen however that eleven of the resulting larvæ were yellowish-green, two brownish-green, and one grey mottled with brown.

The same experiments produced the larvæ of *bidentata* of which typical examples are represented in Plate XVI, figs. 6—11. So far as any conclusion can be drawn from these four small experiments, *betularia* does not seem to be nearly so sensitive or so specialized to this form of environment as *bidentata*. At the same time lichen must have been the cause of the *betularia* larvæ, with one exception, becoming green; for ordinary bark tends strongly to the production of dark forms of this species, even in the presence of a great preponderance of green leaves (Trans. Ent. Soc. Lond., 1892, pp. 331, 332). It will be of interest to repeat these experiments upon a much larger scale, and to introduce the larvæ immediately after hatching; but it does not appear to be probable that this species often exhibits the kind of susceptibility to lichen observed by Dr. Wilson; for (1) it is remarkably sensitive to other surroundings almost throughout its life-history (see pp. 318—320), and (2) the four small experiments, conducted in 1893, do prove considerable sensitiveness to lichen although they did not lead to the production of lichen-like larvæ.

The fortunate discovery of a company of young larvæ

of *Gastropacha quercifolia* by Mr. W. Holland, on July 22nd, 1893, enabled me to experiment on this interesting species, which is well known to present grey and lichen-like forms. The company, evidently the product of a single batch of eggs, was so numerous that I was able to start four experiments with fifteen larvæ in each, on July 28th. All were fed on hawthorn, the food-plant on which the larvæ had been found. This in three cases was intermixed with environments more or less harmonizing with known varieties of the larva—the rough black-barked twigs of the Turkish oak, bramble-stems of a rich reddish-brown colour, and sticks bearing an abundant growth of lichen (probably *Ramalina farinacea* in all cases). In the fourth case the larvæ were as far as possible restricted to the green leaves and youngest shoots of their food-plant. It was, however, impossible altogether to exclude shoots of greyish and reddish-brown shades, and these probably produced some effect.

At first the young larvæ rested chiefly on the food-plant, but soon preferred the bark of the older wood. The change took place simultaneously in each of the three sets containing dark bark and lichen, as will be seen by a glance at the following summary of Mr. Holland's careful notes:—

Dates.	I.		II.		III.	
	Food-plant.	Black bark.	Food-plant.	Lichen-covered bark.	Food-plant.	Reddish-brown bark.
Aug. 1.	12	3	14	1	14	1
Aug. 5.	4	11	3	12	5	7 *
Aug. 9.	3	12	1	14	1	13 †

* 3 on muslin roof. † 1 missing.

There is no reason to suppose that these effects were due to any gradual recovery from disturbance. The recently hatched larvæ were found at the tip of a young shoot on July 22nd, and it is probable that by August 5th the period had been reached when they begin to seek the older wood for the diurnal rest. After August 9th only single larvæ were found except upon the environments which had been provided, and it is probable that, under

entirely natural conditions, larvæ of the same age would never be found upon the leaves or green shoots.

It is of interest to note that the larvæ never rested upon the lichen itself, but upon the bark of the sticks between the masses of lichen. This position is consistent with the larval appearance, which is that of bark partially grown over with lichen.

There can be little doubt that the larva is influenced by the colours of the environment from the time at which it first seeks the older wood, but a certain period is required before the effects become visible. A very obvious adjustment to the three forms of environment was recorded on August 14th—so obvious indeed that the first trace of a visible result might probably have been detected some few days earlier. The adjustment continued to become more complete right up to the beginning of hybernation. On Aug. 31st it was noted that the effects of the three environments had greatly increased. On Sept. 21st a careful comparison of all the larvæ was made upon a white paper background. It was then thought that the adjustment was as complete as it was likely to be before hybernation, and for many larvæ this conclusion was justified. In others however the effects continued to deepen right on into October, as will be seen in the complete account of the experiments. The latest changes probably took place after the larvæ had ceased to feed; indeed they had eaten very little for some time previous to October 3rd. The degree of cryptic adjustment to the three environments which had been reached by the beginning of hybernation can be seen by a glance at the upper part of Plate XVII, where examples of all the types of colouring are represented.

In arranging the larvæ for hybernation many of the environments were shifted, in order to test the existence of any larval susceptibility during this period; and, as no effects were visible when the larvæ were compared after the winter, these same surroundings were continued in each case, right up to the time when the nearly mature larvæ were sent to Lord Walsingham for preservation, in May. The results of various comparisons point to the conclusion that the larvæ of *G. quercifolia* are not susceptible to the colours of the environment after the beginning of hybernation. Thus Plate XVIII, fig. 1 represents a nearly mature larva, of which the appearance before

hybernation is shown in either fig. 4 or fig. 9 on Plate XVII. The latter appearance was a response to an environment of lichen-covered sticks; but after October 16th these were replaced by black-barked twigs, which it is seen produced no effect at all. Again, Plate XVIII, fig. 2 represents a later stage of Plate XVII, fig. 6. Here too the resemblance between older and younger larvæ is very close, although the former had been subjected to the same black environment after October 16th. The negative result of a transfer experiment in the opposite direction is seen in Plate XVII, fig. 14, the representation of a larva which had been exposed to lichen-covered sticks after October 3rd. All the larvæ did not remain as uniform throughout their life-history as these three. Thus Plate XVIII, fig. 3 represents a nearly mature larva of which the appearance before hybernation is seen in Plate XVII, figs. 4 or 9. In this case the larva darkened considerably after the winter, although its environment had not been shifted, but consisted of lichen-covered sticks throughout.

It is probable that the power of adjustment to environment possessed in so marked a degree by this species is specially directed to protection during hybernation, when the food-plants are leafless, and when enemies are often pressed by hunger. But it is doubtless also of importance later on when the larva becomes so much larger and would on this account be far more conspicuous. It is probable, however, that the caterpillar does not wander from its food-plant, and that complete adjustment to the old wood before hybernation is an adequate defence in the following spring and summer. If this be correct there would be no advantage in a prolonged larval susceptibility.

The same relationship between susceptibility and the particular needs of each species is seen in the effect of an environment of green leaves and shoots upon *G. quercifolia, O. bidentata*, and *A. betularia*. The first-named probably invariably rests by day, except for a brief period after leaving the egg, upon the older wood, and the power of adjustment to leaves and young shoots, being altogether useless to it, has never been acquired. The last-named, with its remarkable range of food-plants, including many, such as broom or rose, in which green shoots are a prominent feature, is frequently in a position in which a green colour would best conceal its nearly smooth and cylindrical form; and we find that, as a matter of fact,

it always responds in this way to an environment of the kind described above. *Bidentata* doubtless occupies an intermediate position between the other two species in this respect. The occasions are probably rare, but not altogether wanting, in which it is compelled to develop in a green environment. We find that it has the power of making some considerable approach towards such surroundings, but not of attaining any high degree of resemblance to them. It is probably the case, however, that the tint which it produces on green leaves and shoots is of great value on a pale yellowish-brown bark, which may often form its environment; and it may well be that it is something in common between the light reflected from this and from green leaves which explains the similarity in the effects produced upon the larvæ.

Typical examples of all the forms of *quercifolia* larvæ produced in these experiments were shown alive at the meeting of the Entomological Society of London on May 2nd, 1894, and also at the Soirée of the Royal Society in the same month. A brief account of the exhibit is printed in the Proc. Ent. Soc. Lond., 1894, p. xvi. It is also referred to in Mr. C. G. Barrett's "Lepidoptera of the British Islands" (Lond., 1896, vol. iii, p. 45).

The nearly mature larvæ of *quercifolia*, forming the subject of the experiments described in this memoir, were in almost every case sent to Lord Walsingham, and, with the exception of one which was spoilt, were kindly preserved by him. The specimens are now to be seen in the Hope Department, Oxford University Museum, and in the British Museum of Natural History.

The last series of experiments described in this paper grew out of the surprising restriction of susceptibility to the younger stages of *G. quercifolia*. The results naturally suggested further experiments upon other species well known to be highly sensitive, and I immediately fixed upon *Amphidasis betularia* as the most suitable for the purpose. The investigation was carried out entirely by the present writer, in the laboratory at Wykeham House, Oxford. The results are clearly shown in the accompanying diagram and summary. The Roman figures represent the corresponding stages of larval life. The shaded squares indicate stages passed in a black environment, the unshaded, stages passed in the green surroundings.

Experiment.	I.	II.	III.	IV.	V.	VI.	Colour of mature larvæ.
B							5 green, 1 intermediate.
B^3							1 dark smoky-black. 1 greenish-brown (intermediate). 1 greyish smoky-black.
B^2							9 black (1 dark brownish, 3 with dull greyish patches). 1 grey.
B^1							4 black.
C^1							5 black (overspread with grey). 1 brownish-black.
C							6 dark (with grey patches). 3 intermediate.
A							3 dark (respectively overspread with grey, greenish on sides, and with pale yellowish spots). 1 green (with brown dorsal line and lateral patches).
A^2							2 black. 2 dark overspread with grey. 1 bright green.
A^1							2 green, sprinkled with grey, 1 greenish intermediate. 1 whitish, 2 blackish with grey markings. 1 distinct but dull green with brown broad dorsal line and slight lateral traces.

A glance at the diagram and results proves conclusively that there is no restriction of susceptibility to the younger stages of this species. Experiment B^3 shows the strong influence of a black environment applied only to the two latest stages, while A^1 shows considerable effects traceable to black which was present in the 2nd stage only. When

we furthermore take into account the more intense effects which were produced as additional stages were exposed to a dark environment, we may feel confident that every stage except the 1st and the 5th *or* 6th, is sensitive. These require further experimental testing.

A very interesting and unlooked-for effect was produced in many of the transferred larvæ, viz. an overspreading greyness or the appearance of grey patches. Thus, although the effect of the earlier surroundings appeared at first sight to be entirely obliterated, the larvæ were nevertheless unable to develop their full and characteristic response to the later environment. Details will be found in the account of the experiments. It only remains to point out that experiment A^1 probably indicates that these larvæ are susceptible to the colours of the branches at a period when they are at any rate chiefly to be found upon the leaves and leaf-stalks, and that there was some evidence to show that the influence of environment may be largely a question of time, so that of several larvæ passing the same stages in given surroundings, those which grow most slowly are, on the whole, the most affected.

First Experiments with Larvæ of O. bidentata (1893).

The larvæ from the first set of eggs sent by Mr. Porritt from Yorkshire hatched at about the same time, so that nearly all the experiments recorded on pages 322—325 in a tabular form were started on the same day, May 22nd. The observations were in part conducted by Mr. Holland and in part by me, as is indicated by the initials or name under the dates in the left-hand column of the table. Hence in the account of each experiment there is the opportunity of comparing two independent sets of observations.

The food-plant made use of in all these experiments was the black poplar (*Populus nigra*).

A careful comparison of the results of the 10 sets of experiments (viz. I to IX, including VA) was made by the present writer on July 6th, 1893, all the larvæ being placed on a background of white. At this time all except one were in the last stages, and many in all the cylinders were approaching maturity. Of the forms of environment made use of, 7 had produced dark larvæ, and 3 light.

A. DARK LARVÆ OF BIDENTATA ON JULY 6TH.

I. *Black sticks.*—Fourteen out of the 15 larvæ were very black, the exception being quite small and probably in the 3rd stage. These larvæ were the darkest of all the sets.

II. *Deep blue paper spills.*—These 12 larvæ were very dark, coming next to those upon the black twigs in this respect. The dark purplish-black colour was also very uniform over the whole larval surface corresponding to the unvarying tints of the environment.

III. *Purplish-brown twigs.*—These 15 larvæ were *slightly* more variegated than II, in correspondence with the less uniform darkness of their environment. Except for this slight introduction of rather lighter shades these larvæ were as dark as II.

IV. *White spotted purplish-brown twigs.*—These 16 larvæ were dark, but distinctly lighter than those of the three previous sets. They also varied a little, whereas the groups first described were more uniform. Although the relative lightness and the darkness of these larvæ, as compared with III, corresponded to the *general* effect of their respective environments, there was no marked resemblance to the special details of the twigs which had been carefully selected for Experiment IV.

V. *Brown twigs.*—The 17 larvæ were distinctly brown and not nearly so black or purplish as the preceding sets. The shade of brown varied, being much lighter in the smaller larvæ. The brown larval surface was also somewhat variegated with different shades of the same colour.

VA. *Bark overspread with a bright yellowish-green powdery lichen.*—The 18 larvæ varied very greatly, some being as dark as the blackest of set I; many were variegated with shades of brown, harmonizing well with the environment; for the lichen soon lost its green tint and became various shades of brown. This is the only note relating to this experiment which has been found. There is no doubt that the young larvæ were introduced on May 22nd or 23rd.

VI. *Lichen-covered sticks.*—The lichen was probably dead and had become much paler. These larvæ too were much lighter than any of the previous sets, although a few were quite dark. Nearly all were light brown and much variegated with shades of brown, harmonizing well with the environment.

Of the 7 sets of larvæ described above, the degrees of

Dates in 1893.	I. Black twigs of Turkish oak.	II. Deep blue paper spills.	III. Dark purplish-brown glossy twigs probably of birch.	IV. White-spotted purplish-brown twigs of birch.
May 22. (E. B. P.)	15 Young larvæ introduced.	(May 23.) 15 young larvæ introduced.	15 larvæ introduced (just hatched).	16 young larvæ introduced.
June 11. (E. B. P.)	(June 9.) Re-fed.	12 larvæ counted; becoming very dark.	(June 16). All 15 dark like the twigs, but not markedly purplish.	15 counted.
June 19. (E. B. P.)	(June 17.) All 15 very black like the twigs.	All 12 very dark.	All 15 on twigs, very dark and purplish.	12 larvæ on twigs, 4 on green. All dark, but greyer than those in III, and not so dark as latter.
June 25. (E. B. P.)	(June 22.) As before. All at rest on twigs.	As before. All on spills.		
July 1. (E. B. P.)	As before: all on twigs.		(June 27.) All 15 dark brown.	(June 27.) Re-fed.
July 6. Careful comparison on white paper. (E. B. P.)	2 at rest on green, 13 on twigs. All very black.	9 on spills, 1 on green, 2 not noted. All 12 of a uniform dark purplish-black.	All 15 on twigs. All very dark.	13 on twigs, 3 on green. Dark, but much lighter and less constant than III.
July 10. (W. Holland.)	2 at rest on green, 13 on twigs. All very black.	8 on spills, 4 on green. All very dark.	14 on twigs, 1 on green. All dark purplish-brown.	15 on twigs, 1 on green. The larvæ remain lighter in tint than III.
July 12. (W. Holland.)	15 on twigs.	9 on spills, 3 on green.	13 on twigs, 2 on green.	13 on twigs, 3 on leaves.

V. Reddish-brown twigs.	VI. Lichen-covered sticks.	VII. Weathered pale grey barkless twigs.	VIII. Green leaves and shoots of food-plant (*Populus nigra*).	IX. Orange paper spills.
17 young larvæ introduced.	14 young larvæ introduced.	(June 3.) 15 young larvæ introduced.	15 young larvæ introduced.	15 young larvæ introduced.
All 17 evidently becoming brown like the twigs.	(June 9.) Re-fed.	Apparently becoming light brownish and approaching colour of twigs.	All 15 *very* pale brown	
Brown like the twigs.	14 larvæ; variable, with no marked resemblance to lichen.	(June 18.) 13 on twigs, 1 on muslin roof, 1 on green. All closely resemble twigs.	(June 17.) All 15 very pale brown, some faintly greenish.	6 on spills, 1 on muslin roof, 8 on green. All very light brown.
As before. 14 on twigs, 2 on green, 1 uncertain.	10 on sticks, 4 on green. Some distinctly variegated light and dark brown, but no green marks yet.	(June 22.) 10 on twigs, 1 on muslin, 3 on green.	(June 22). As before.	14 on spills, 1 on green. Colour as before.
All 17 on twigs. They become much lighter when changing skin.	9 on sticks, 5 on green. Larvæ still very variegated.	13 on twigs, 1 on green.		
17 on twigs. Distinctly brown, and not purplish like III and IV.	12 on sticks, 2 on green. A few dark but mostly light and variegated with shades of brown.	All 14 light grey and harmonizing perfectly with twigs.	14 larvæ. All very light brown, but not greenish.	All 15 on spills. Larvæ resemble VIII, only not *quite* so light.
16 on twigs, 1 on green. All brown as before.	12 on sticks, 2 on green. Two larvæ variegated with dark green: the rest as before, but darker brown.	10 on twigs, 4 on green. 1 larva injured. Appearance as before.		11 on spills, 4 on green. Very light yellowish-brown.
16 on twigs, 1 on green.	13 on sticks, 1 on green. 4 larvæ with dark green patches, strongly developed in 2 of them.	11 on twigs, 2 on green.		12 on spills, 3 on green.

Dates in 1893.	I. Black twigs of Turkish oak.	II. Deep blue paper spills.	III. Dark purplish-brown glossy twigs probably of birch.	IV. White-spotted purplish-brown twigs of birch.
July 15. (W. Holland.)	15 on twigs. All very black.	10 on spills, 2 on green. All very dark.	14 on twigs, 1 on green. All very dark purplish-brown.	12 on twigs, 4 on green. Colour darkish brown but distinctly paler than III.
July 18. (W. Holland.)	As before.	As before.	As before.	As before.
July 23. (W. Holland.)	As before.	Some mature and spinning up.	As before.	As before.
July 27. Careful comparison (E. B. P.)	Some pupating. All black, but one has *very* faint traces of green on sides anteriorly. These larvæ blacker and less purple than those with blue spills (II).	6 larvæ remain, nearly mature. All *very* dark purplish, almost black, as on many previous occasions.	All a very uniform dark purplish-brown, almost black, but not so much so as those with the blue spills.	All dark greyish-brown and very uniform.
July 28. (W. Holland.)	8 larvæ still feeding. All on twigs.	5 still feeding. 4 on spills, 1 on leaf.	9 still feeding: all on twigs. (July 30.) A typical larva painted; shown in Plate XVI, fig. 3.	12 still feeding: all on twigs. (July 30.) A typical larva painted; shown in Plate XVI, fig. 4.
Aug. 3. (W. Holland.)	(July 31.) A typical larva painted; shown in Plate XVI, fig. 1. (Aug. 4.) Re-fed.		5 still feeding. 4 on twigs, 1 on green.	6 feeding. All on twigs.
(Aug. 8. W. Holland.)	Re-fed. One or two still feeding.		As before. All 5 on twigs.	5 feeding: all on twigs. Colour as before. (Aug. 19.) 3 still feeding.

V. Reddish-brown twigs.	VI. Lichen-covered sticks.	VII. Weathered pale grey barkless twigs.	VIII. Green leaves and shoots of food-plant (*Populus nigra*).	IX. Orange paper spills.
10 on twigs, 7 on green. All brown like twigs.	10 on sticks, 4 on green. 6 with green patches, very marked in 2.	12 on twigs, 1 on green. All very pale and extremely like twigs.		11 on spills, 4 on green. All pale yellowish-brown.
As before.	As before. Some larvæ mature.	As before.		As before.
Some larvæ mature.	Others mature.	As before.		Some larvæ mature.
Some larvæ have become of a much darker brown lately. The change probably due to maturity.	3 or 4 with green patches, 3 or 4 with brown.	All now much darker, but still like the darker twigs in the cylinder. Some mature.	Larvæ very light brown, like IX.	Very light brown, like VIII.
10 still feeding. 8 on twigs, 2 on green.	7 feeding. All on sticks.	10 feeding; all on twigs. A typical larva was painted; shown on Plate XVI, fig. 2.	(July 31.) A typical larva painted; shown on Plate XVI, fig. 5.	7 feeding, all on spills.
4 feeding. All on twigs.	2 feeding.	6 on twigs, 1 on green.	6 feeding. All pale brown.	5 feeding. 4 on spills, 1 on muslin.
(Aug. 19.) 1 still feeding.	(Aug. 18.) All pupated.	7 still feeding. (Aug. 19.) 2 still feeding.	5 feeding, 1 dead. (Aug. 19.) 5 feeding; all very pale brown. 4 feeding on Aug. 26, and 1 or more on Aug. 31.	As before. All 5 on spills. (Aug. 20.) All pupated.

darkness follow in the same order as that in which the results are recorded, except that V and VA were much alike, the brown differing in tint rather than in depth. VI were much lighter than any of the others.

B. LIGHT LARVÆ OF BIDENTATA ON JULY 6TH.

VII. *Weathered grey barkless twigs.*—The larvæ were very light; of a distinct grey colour, harmonizing perfectly with the environment.

VIII. *Green leaves and shoots of food-plant.*—The 14 larvæ were all *very* light brown but not at all greenish.

IX. *Orange paper spills.*—The 15 larvæ closely resembled VIII, but were not quite so light.

Some of the results of this comparison have been incorporated in the tabular statement. Another careful comparison was made on July 27th, but in this case it was possible to include the whole in the table.

SECOND EXPERIMENTS WITH LARVÆ OF O. BIDENTATA. EXPERIMENTS WITH LICHEN ON LARVÆ OF A. BETULARIA (1893).

In sending the second mixed set of eggs of *bidentata*, Mr. Porritt wrote on June 13th, 1893—"I certainly had no expectation of seeing any more *Odontopera bidentata* this season. However, when collecting on Saturday, at Sledmere, in a high wood on the Yorkshire Wolds, I found several! Two of the females have deposited a few eggs, which I forward at once with this. Sledmere is on the chalk, and *bidentata* there is quite of a different type to our West Riding moth, being of the pale, ochreous banded, distinctly southern form."

The eggs were placed in a single cylinder, and as soon as a sufficient number of larvæ had hatched, I started Experiments X to XV, between June 27th and July 3rd, the 14 larvæ of *A. betularia* received from Mr. Arthur Sidgwick being divided between Experiments XII to XV. Experiments XVI to XVIII were started on August 3rd by Mr. Holland, with the latest larvæ of *bidentata*. All the observations on Experiments X to XVIII recorded in the tabular statement on pages 328—331 were made by Mr. Holland. The food-plant used throughout was *Populus nigra*. When flat pieces of bark were introduced (XII,

XIII, XIV, as well as VA in the first series of experiments), they were tied together in pairs with the lichen-covered surfaces outwards.

EXPERIMENTS XVI, XVII, AND XVIII WITH THE LARVÆ OF O. BIDENTATA UPON GREEN LEAVES AND SHOOTS OF THE FOOD-PLANT (*Populus nigra*).

The results of these experiments were uniform, and require so little description that a tabular form of presentation is unnecessary.

Experiments XVI (10 young larvæ), XVII (17 larvæ), and XVIII (14 larvæ) were begun by Mr. Holland on August 3rd, 1893. He recorded that the larvæ of XVI were pale brown, 2 of them rather variegated; while of XVII, 14 were pale brown and 3 rather variegated. Of XVIII no record was made. The larvæ were the last hatched from the mixed batch of eggs which supplied the material for Experiments X to XV.

August 8th. All re-fed. Sixteen larvæ in XVII.

August 12th. XVI and XVIII re-fed; the latter noted as nearly all pale brown, a few rather variegated.

August 15th and *19th.* XVI and XVIII re-fed; larvæ 10 and 14 respectively.

August 17th. XVII re-fed; 16 larvæ.

August 21st. XVII re-fed; 8 larvæ had escaped. The 10 larvæ in XVI were all of a pale brown colour.

August 22nd. XVIII, 13 larvæ pale brown, 1 darker with a few green markings.

August 26th and *31st.* All re-fed; larvæ 10, 8, and 14 respectively.

September 5th. XVI, becoming mature (2 still feeding on 9th and 13th; no further notes on this set). XVII, 7 larvæ, all pale brown. XVIII, 14 larvæ.

September 8th. XVII, 2 mature (all mature on 13th). XVIII, 1 mature, 1 dead. Of 12 still feeding, 10 pale brown, 2 rather darker brown. Two out of the 12 slightly tinged with green.

September 13th. XVIII, 6 still feeding. On the 18th they were neither pupating nor feeding, and on the 23rd the last died. It appears possible that there was a tendency towards hybernation on the part of the larvæ with the slowest rate of growth.

Dates in 1893.	X. Dark purplish-brown glossy twigs, probably of birch.	XI. Reddish-brown twigs.	XII. Bark covered with bright yellowish-green powdery lichen, the colour of which faded and left the dark bark.
June 27.	(July 2.) 13 small larvæ introduced, mostly in 2nd stage.	(July 3.) 20 larvæ introduced, at beginning of second stage. The smallest about 5·5 mm. long, and none much longer.	3 *betularia*, smaller than in XIII and XV, introduced. 15 *bidentata*, similar to those introduced in XIII.
July 12.	Half of the larvæ becoming purplish.	20 counted. A few becoming reddish-brown.	3 *betularia*, pale yellowish-green. 15 *bidentata* variegated.
July 15.	Re-fed.	Re-fed. 20 counted.	Re-fed. 3 and 15 counted.
July 18.	9 on twigs, 4 on green.	10 on twigs, 8 on green. Larvæ becoming dark reddish-brown and variegated.	2 *betularia*, mature. 14 *bidentata*, all darkish, variegated.
July 23.	(July 24.) 12 on twigs, 1 on green. Almost all dark.	15 on twigs, 1 on green, 1 on muslin. As before.	Last *betularia* mature. 10 *bidentata* on bark, 1 on green, 3 on muslin. All variegated brown, slightly touched with green and with white dashes along sides.
July 28.	12 on twigs, 1 on green. 10 dark brown, variegated; 3 paler and less variegated.	(July 27.) 12 on twigs, 4 on green, 1 on muslin. 8 changed skin and of a more uniform brown colour.	13, all on bark (as also on Aug. 1). About half darker, but all still variegated. All except 2 with more or less green.
Aug. 3.	11 on twigs, 2 on green. 11 dark brown and more uniform than before, 2 rather paler. One or two have patches of pale green.	(July 31.) 14 on twigs, 1 on green. 8 brown like the twigs; 4 paler and less uniform; 3 variegated and patched with green. (Aug. 4.) 12 on twigs, 2 on green, 1 on muslin. As before.	12 on bark, 1 on muslin. As before, but have become darker. This is the darkest set of Experiments XII to XV.

XIII. Bark covered with bluish-green lichen, probably *Physcia pulverulenta.*	XIV. Bark covered with orange lichen, probably *Physcia parietina*, combined with *P. pulverulenta.*	XV. Lichen-covered sticks. The lichen probably *Ramalina farinacea.*
3 *betularia*, about 12 mm. long, introduced. 12 *bidentata*, about 6 mm. long, introduced, mostly changing skin.	(June 25.) 4 *betularia*, about 7 mm. long, introduced. 1 changing first or second skin, others rather larger. 8 *bidentata*, about 6 mm. long, introduced.	4 *betularia* and 10 *bidentata* introduced. Both similar to those in XIII.
2 *betularia* yellowish-green, 1 brownish-green. 10 *bidentata* much variegated.	3 *betularia* pale yellowish-green, 1 grey mottled with brown. 2 much smaller than others. *Bidentata* rather pale, variegated.	3 *betularia* yellowish-green, 1 dark brownish-green. *Bidentata* mottled.
Re-fed. 3 and 10 counted.	2 yellowish - green *betularia* still feeding.	4 and 10 counted, *Betularia* as before.
Betularia, all mature. 9 *bidentata* much variegated.	All *betularia* mature. 4 *bidentata* on bark, 3 on green. All brightly variegated.	3 *betularia* mature, 1 escaped. 10 *bidentata* dark, mottled; some green on sides.
8 on bark, 1 on green. 2 seemed unhealthy. All much variegated with pale brown and green. Small white dashes on sides.	4 on bark, 3 on green. All brightly variegated with shades of brown, and patched with green.	(July 24.) 8 on sticks, 1 on green, 1 on muslin. Nearly all patched with green.
7 on bark, 1 on green. Colours as before. Typical larvæ painted, Aug. 1st and 3rd, shown in Plate XVI, figs. 6 and 7.	6 on bark, 1 on green. As before.	10 on sticks. 6 darkish brown mottled with green and paler brown: white dashes on sides. 3 similar but paler. 1 without green.
8 on bark. 1 unhealthy. 6 brown, lighter than in XII, brightly mottled with paler brown and green. 1 paler, less variegated, with little green. 1 small and pale, without green. White lateral dashes only on former 6.	7 on bark. All changed skin. 1 blackish-brown, 4 darkish brown, 2 lighter brown; all variegated with much green, and the darker ones also with paler brown. All with lateral white dashes.	7 brown, more or less patched with green, some very strongly. 1 grey and brown strongly patched with pale green. 2 pale brown with little green. Most show white lateral dashes.

Dates in 1893.	X. Dark purplish-brown glossy twigs, probably of birch.	XI. Reddish-brown twigs.	XII. Bark covered with bright yellowish-green powdery lichen, the colour of which faded and left the dark bark.
Aug. 8.	9 on twigs, 4 on green. All dark brown, some with a little green.	(Aug. 7.) 14 on twigs, 1 on green.	10 on bark, 3 on green. 10 of a rich dark brown patched with lighter brown and green: 3 lighter brown variegated with still paler brown and green. All but one of these paler larvæ with little white dashes on sides. The green marks less pronounced than in XIII and XIV.
Aug. 12.	(Aug. 10.) 11 on twigs, 2 on green. 11 purplish-brown, 2 rather paler. Several larvæ with green patches on sides.	(Aug. 10.) 13 on twigs, 2 on green. All brown, mostly rather darker than twigs, but 4 rather paler. Several patched with green.	10 on bark, 2 on green, 1 on muslin.
Aug. 15.	12 on twigs, 1 on green. As before.	12 on twigs, 3 on green. As before.	(Aug. 14.) 10 on bark, 2 on green. All but 2 very dark brown, with far less green than XIII and XIV.
Aug. 19.	10 on twigs, 2 on green. Purplish-brown, several with a little green. 2 rather paler brown.	10 on twigs, 5 on green. All brown, several patched with green.	12 larvæ, as before.
Aug. 21.	8 on twigs, 4 on green. 10 purplish-brown, 2 brown. Only 1 or 2 slightly marked with green.	(Aug. 22.) 12 on twigs, 3 on green. All brown, 8 resembling twigs, 2 rather darker, 2 rather lighter.	(Aug. 22.) 9 on bark, 3 on green.
Aug. 26.	(Aug. 25.) 12 on sticks.	Re-fed.	10 on bark, 2 dead.
Aug. 30.	9 on sticks, 2 on green. 1 mature.	2 mature, and 2 more on Aug. 31.	6 on bark, 4 on green. The colour of the lichen had faded, and left the dark bark.
Sept. 5.	Mostly mature. 2 feeding Sept. 8. All mature Sept. 13.	(Sept. 4.) Nearly all mature. Only 1 feeding Sept. 9.	(Sept. 4.) Larvæ becoming mature. A few still feeding Sept. 9 and 13.

XIII. Bark covered with bluish-green lichen, probably *Physcia pulverulenta.*	XIV. Bark covered with orange lichen, probably *Physcia parietina*, combined with *P. pulverulenta.*	XV. Lichen-covered sticks. The lichen probably *Ramalina farinacea.*
5 on bark, 2 on green. As before.	7 on bark. As before. Typical larvæ painted Aug. 4 and 5, shown in Plate XVI, figs. 8 and 9.	10 on sticks. As before.
(Aug. 14.) 7 on bark. As before, except that smallest larva now marked with green.		(Aug. 10.) A typical larva painted, shown in Plate XVI, fig. 10.
	(Aug. 14.) 7 on bark. Lighter and greyer ground-colour. Green patches very marked.	(Aug. 14.) 10 on sticks. 8 grey-brown mottled with darker brown and much green, so that some are half green ; 2 similar but browner.
7 on bark. Brown, variegated with paler brown and with green (strongly 5, less strongly 2).	5 on bark, 2 on green. Colour as before.	10 on sticks. Colour as before.
6 on bark, 1 on green. Colour as before.	6 on bark. All variegated greyish-brown, strongly patched with green. White lateral dashes.	10 on sticks. As before.
(Aug. 25.) 6 on bark, 1 on green.	(Aug. 25.) 6 on bark.	(Aug. 25.) 9 on twigs, 1 on floor.
2 mature. A typical larva painted Aug. 31, shown in Plate XVI, fig. 11.	6 on bark. Colour as on Aug. 21.	Larvæ becoming mature.
(Sept. 4.) All mature.	All mature except one. Last mature Sept. 8.	All mature.

Experiments upon the Larvæ of Gastropacha quercifolia (1893–4).

On July 22nd, 1893, Mr. W. Holland found a company of young larvæ of this species crowded together towards the end of a shoot of hawthorn near Steeple Aston, Oxfordshire. They were all the same size, and had evidently not long before hatched from a single batch of eggs. Thus was afforded the opportunity of trying another set of experiments upon a larva which is known sometimes to assume a lichen-like appearance. Furthermore, there was the additional interest of testing larval susceptibility to environment before, during, and after hybernation. The food-plant employed throughout was hawthorn. The present writer is responsible for the starting of the experiments, the arrangements for hybernation, and the comparison of larvæ on September 21st, October 3rd to November 3rd, March 26th, April 27th, May 7th and 25th. The other records were chiefly made by Mr. W. Holland, in much less part by the present writer.

I. *G. quercifolia.*

July 28*th*, 1893. Fifteen larvæ of *quercifolia* placed with intensely black twigs of the Turkish oak (*Quercus cerris*), intermixed with their food-plant, hawthorn. They were re-fed and examined on the following dates.

August 1*st.* Twelve larvæ on the green leaves and shoots, 3 on the black twigs. All blackish-grey in colour.

August 5*th.* Four larvæ on the leaves and shoots, 11 on the black twigs.

August 9*th.* Three larvæ on the leaves and shoots, 12 on the black twigs.

August 14*th.* Fifteen larvæ counted; all on the black twigs. The colours were black and white with a little grey.

August 19*th.* All 15 larvæ on black twigs.

August 22*nd.* All 15 larvæ on black twigs.

August 31*st.* All 15 larvæ on black twigs. The larvæ were now much blacker, but white markings were still present.

September 4*th.* Fifteen counted.

September 7*th.* Fifteen larvæ on black twigs.

September 9*th.* Fifteen lārvæ on black twigs.

September 14*th*. Fifteen larvæ on black twigs, 2 blackish, 13 black with white markings.

September 16*th*. Fifteen larvæ on black twigs.

September 18*th*. Fifteen counted.

September 21*st*. Fourteen larvæ on twigs, and 1 little one on leaf. The larvæ were re-fed on September 26th and 30th.

II. *G. quercifolia.*

July 28*th*, 1893. Fifteen larvæ of *quercifolia* placed with sticks profusely covered with lichen (probably *Ramalina farinacea* was employed thoughout) intermixed with their food-plant, hawthorn. They were re-fed and examined on the following dates.

August 1*st*. One larva on lichen-covered stick; all the others on leaves and leaf-stalks. All blackish-grey in colour.

August 5*th*. Twelve larvæ on lichen-covered sticks; 3 on food-plant.

August 9*th*. Fourteen larvæ on lichen-covered sticks; 1 on food-plant.

August 14*th*. Fourteen larvæ on lichen-covered sticks. Colours black with white and grey markings; the latter larger than on the larvæ of the other experiments.

August 19*th*. Thirteen larvæ on sticks; 1 on food-plant.

August 22*nd*. Thirteen larvæ on sticks.

August 26*th*. Thirteen larvæ on sticks.

August 31*st*. Thirteen larvæ on sticks. The white and grey markings had now developed to a much greater extent.

September 4*th*. Thirteen larvæ on sticks.

September 9*th*. Thirteen larvæ on sticks.

September 14*th*. Twelve larvæ on sticks Colours white and grey and black, except in the case of 2 larvæ without any black.

September 16*th*. Twelve larvæ counted.

September 18*th*. Twelve larvæ on sticks.

September 21*st*. Nine larvæ on sticks; 3 on the twigs of hawthorn. At this time of the year it was almost impossible to get a sufficient quantity of the green shoots of the hawthorn, so that darker twigs were sometimes included, and upon these the larvæ occasionally rested. The larvæ never rested upon the lichen itself, but on the surface of the bark between the masses.

The 12 larvæ were re-fed on September 26th and 30th, and on October 3rd and 7th.

III. *G. quercifolia.*

July 28*th*, 1893. Fifteen of the *quercifolia* placed with red-brown stems of the bramble, intermixed with their food-plant, hawthorn. They were re-fed and examined on the following dates.

August 1*st.* Only 1 resting on bramble stem, others on leaf-stalks. Blackish-grey in colour.

August 5*th.* Seven on stems, 5 on green parts of food-plant, 3 on gauze top of cylinder.

August 9*th.* Thirteen on stems, 1 on green parts of food-plant, 1 missing.

August 14*th.* Fourteen on stems. Some black with white markings, some grey and some mottled reddish-brown.

August 19*th.* Fourteen on stems.

August 22*nd.* One missing, all on stems.

August 26*th.* Thirteen counted.

August 31*st.* Thirteen on stems. All were now grey-brown with black and white markings.

September 4*th.* Thirteen on stems.

September 7*th.* Thirteen on stems.

September 9*th.* Thirteen on stems.

September 14*th.* The colours were now as follows:—1 brown and grey with white markings, 2 brown with white markings, 3 brown with various shades of grey, 3 grey and brown with white markings, 2 grey with white markings and brown patches, 2 dark grey with white markings.

September 16*th.* Thirteen counted.

September 18*th.* Thirteen on stems.

September 21*st.* Twelve on stems; 1 on hawthorn twig.

They were also re-fed on September 26th, 30th, October 3rd and 7th.

IV. *G. quercifolia.*

July 28*th*, 1893. Fifteen larvæ of *quercifolia* placed with green leaves and shoots of the hawthorn. They were re-fed and examined on the following dates.

August 4*th.* Fifteen counted. Blackish-grey in colour.

August 8*th.* Fifteen counted.

August 14th. Fifteen counted. Rather variable in colour, but somewhat greyer than at first.

August 19th. Fifteen counted.

August 22nd. Fifteen counted.

August 26th. Fourteen counted.

September 1st. Fourteen counted.

September 5th. Fourteen counted.

September 9th. Fourteen counted.

September 13th. Fourteen counted. Colour variable: 3 black and white; 9 grey and black-and-white; 2 grey and brown-and-white.

September 16th. Fourteen counted.

September 18th. Fourteen counted.

September 21st. Fourteen counted. All on the shoots of the hawthorn.

September 26th. Fourteen counted.

October 3rd. Fourteen counted.

October 7th. Fourteen counted.

October 18th. Fourteen counted. Colour unchanged, but rather darker than when last noted. Arranged for hybernation in two muslin bags on the hawthorn tree described on p. 337; one bag containing the 7 darkest, the other the 7 lightest.

First General Comparison (September 21st), all the quercifolia Larvæ being placed upon a uniform background of white paper.

I. *G. quercifolia.*

As regards the larvæ with black twigs of Turkish oak, it should be noted that the moisture in the glass cylinders had encouraged the growth of small whitish spots of mould upon the dark bark, and it is possible that some effect may have been produced by their presence in the environment.

Of the 15 larvæ, 6 were remarkable for the very slight development of light markings upon the intense black ground-colour: in one larva indeed the light markings were altogether wanting. The remaining 9 larvæ were black, chequered with white markings, which were however far less developed than in the former group which had been with lichen-covered sticks. The ground-colour of these 15 larvæ differed strongly from that of all the others in its deep black shade.

Two of the 6 caterpillars described above, including the uniformly dark one, were selected for painting, together with a representative of the 9 chequered larvæ. The larva without white markings was painted by Mr. Bayzand on September 23rd, and is shown on Plate XVII, fig. 2; the one with minute white markings on September 26th (Plate XVII, fig. 3), and the chequered larva on September 25th (Plate XVII, fig. 1).

II. *G. quercifolia.*

By far the most marked result was seen in the 12 larvæ with an environment of lichen-covered sticks. Not one of the 12 could be mistaken for any larva of the other groups. In the case of 4 larvæ the effects were especially marked, these being of a light colour over nearly the whole of the exposed surface, the black ground-colour quite replaced by a pale brownish tint in one and by grey in the others. The 8 remaining larvæ closely resembled each other, being dark chequered with white; but the ground-colour, although dark, was not black like that of the larvæ with Turkish oak (I), while the white markings possessed a greyish tinge in one larva and a bluish in another.

The 4 larvæ first mentioned were separated from the others for painting at this date, together with the one in which the markings were bluish-white, and another representative of the commonest type of appearance, viz. a dark ground-colour with white markings.

III. *G. quercifolia.*

The ground-colour of all the larvæ with brown bramble-stems was very dusky and brownish. Five of them had a distinct brown patch on each side of the 2nd abdominal segment, partially extending on to the 1st, and another patch on the dorsal surface of the 5th abdominal. The dorsal hump on the 8th abdominal, and in some larvæ the area surrounding its base, were also brown. In the remaining larvæ the light markings were more generally greyish than white, and were often evanescent. Of the first-named 5 larvæ only one had the light markings well developed, and this was selected for painting together with another in which these markings were almost absent. The remaining larvæ were similarly represented by the larva with the white markings best developed and the one in which they were feeblest.

IV. *G. quercifolia.*

The larvæ with green leaves and shoots were very varied, showing tendencies in the direction of all the other groups, but chiefly resembling the chequered black-and-white larvæ with the black twigs of Turkish oak, although the ground-colour was not nearly so dark. A few tended towards the greater development of the light markings which was characteristic of the group with the lichen-covered sticks, while all of them approached the larvæ with the brown stems in the dusky tint of the dark ground-colour. There was no reason for painting any of these larvæ.

Arrangements for Hybernation and final Comparison of the quercifolia larvæ before Hybernation.

I. *G. quercifolia.*

October 3rd. Larvæ with black twigs. It was evident that the larvæ were ready to hybernate. They had eaten very little, and some of them were spinning a foot-hold. The size was that shown on Plate XVII, figs. 1 to 3. A great change had taken place since the last comparison on September 21st: only 3 larvæ instead of 9 were now chequered black-and-white, 6 having become nearly as dark as 5 out of the 6 darkest members of the group. The white patches of the chequered individual painted on September 25th were now far duller and less conspicuous. The larvæ of this and all the other series were specially arranged so as to test for the existence of any susceptibility to the colours of the environment during hybernation. All were enclosed in muslin sleeves upon a large hawthorn tree, with pink double flowers, in the garden of Wykeham House, Oxford. It should be noted that the branches enclosed in the sleeves were very dark, although not so intense a black as the twigs of the Turkish oak.

A. The 3 chequered black-and-white larvæ were enclosed with an abundance of black twigs of Turkish oak.

B. The 5 darkest were similarly placed with lichen-covered twigs.

C. Six dark larvæ, but not quite so dark as the last lot, were similarly enclosed with black twigs.

II. *G. quercifolia.*

October 16*th.* Larvæ with lichen-covered sticks. Many of these larvæ had also undergone considerable changes since September 21st; so much so indeed in certain cases, that two of the examples set aside for painting had to be changed for others which better represented the appearance borne by the former when they were selected. Of the 4 lightest larvæ on September 21st only one remained greyish (painted October 2nd, shown in Plate XVII, fig. 6); 2 were now of a brownish tinge (painted October 3rd, fig. 4, and October 7th, fig. 9, Plate XVII); while the 4th had become so much darker that another brownish larva was substituted for painting (painted October 6th, fig. 5, Plate XVII). The latter was not, however, as light as any of the other 3 set aside on Sept. 21st. Of the other 2 darker larvæ previously selected for painting, the one with bluish-white spots had altered, and another more like its former appearance was substituted (painted October 9th, Fig. 8, Plate XVII). The remaining 6 dark, white-marked unpainted larvæ had not changed, except that the white marks upon two of them had become smaller and less conspicuous.

These 6 larvæ, with the dark, white-marked one which was painted on October 10th, and is shown on Plate XVII, fig. 7, were divided into two groups for hybernation.

D. Four dark, white-marked larvæ, including the darkest larva of all the 7 with the smallest white spots, were enclosed with lichen-covered sticks.

E. Three dark, white-marked larvæ, including the darkest larva but one of all the 7, were enclosed with black twigs of the Turkish oak.

The 3 lightest larvæ were thus treated.

F. One larva was enclosed with lichen-covered sticks (Plate XVII, figs. 4 or 9).

G. Two larvæ, including the greyish one (Plate XVII, fig. 6), were enclosed with black twigs. The other larva is represented in Plate XVII, figs. 4 or 9.

H. The two remaining larvæ which had been substituted for painting, viz. the brownish larva (Plate XVII, fig. 5), and the dark one with bluish-white marks (Plate XVII, fig. 8), were enclosed with lichen-covered sticks.

III. *G. quercifolia.*

November 3rd. The larvæ with brown bramble-stems were compared and arranged for hybernation. The larvæ were more distinctly brown and more uniformly so than when last compared. The brown patches on three parts of the surface of certain larvæ, viz. the 2nd, 5th, and 8th abdominal segments, were still evident and more distinct than ever. On some individuals they had increased in size. In only a single larva were the light patches at all large and conspicuous. Seven larvæ were very uniform in appearance—dark brown with light brown patches generally present. The remaining 4 larvæ were also dark brown, but 1 was distinctly marked with white, 2 less distinctly marked with brownish-white, while the dorsal surface of 1 was overspread with grey. The latter larva was painted on October 17th (Plate XVII, fig. 12). One of the brownish-white-marked larvæ was painted on October 13th (Plate XVII, fig. 10); and 2 of the 7 first described were painted on September 30th (Plate XVII, fig. 11) and October 16th (Plate XVII, fig. 13).

This group of larvæ was arranged for hybernation as follows:—

I. Four of the 7 uniform larvæ were enclosed with lichen-covered sticks.

J. The remaining 3 were enclosed with black twigs.

K. The 4 more spotted or lighter larvæ were enclosed with brown stems.

First General Comparison after hybernation, March 26th, 1894.

The weather was very warm on March 25th and 26th, and the buds of the hawthorn were well out.

I. THE 14 QUERCIFOLIA LARVÆ ON BLACK TWIGS BEFORE HYBERNATION.

A. *The 3 chequered larvæ with black twigs.*—All three larvæ were quite healthy, and freely moved about when disturbed. Two were at rest on the black twigs, 1 was walking about, probably disturbed by the examination. They had eaten many of the buds, and one had changed

its skin probably since hybernation: the old skin was found in the muslin bag.

B. *The 5 darkest larvæ with lichen-covered sticks.*—All the larvæ were in the same healthy and vigorous condition as those just described, and had eaten the buds of the hawthorn. Every trace of the winter torpor had disappeared, and they moved freely when touched. The larvæ were uniformly dark brown, and quite unaffected by the presence of the lichen. Four were resting on a branch of the hawthorn, while one was on the muslin.

C. *The 6 dark larvæ with black twigs.*—Three were dead and dried up, 2 in the bag and 1 still fixed to a branch of the hawthorn. Of the living larvæ, 2 were fixed to the muslin and 1 to a branch. One larva appeared to be unhealthy. One had changed its skin, and the hawthorn-buds had been eaten. All the larvæ, including the dead ones, were uniformly dark.

It was clear from this comparison that no change had been wrought by the winter surroundings.

II. THE 12 QUERCIFOLIA LARVÆ WITH LICHEN-COVERED STICKS BEFORE HYBERNATION.

D. *The 4 dark, white-marked larvæ, including the darkest of the* 12, *with lichen-covered sticks.*—These larvæ had evidently eaten, and were healthy and easily disturbed. Three were on branches of the hawthorn, and 1 on a lichen-covered stick, but all had left their silken foot-holds. All retained the appearance they possessed before hybernation: the contrast between dark ground-colour and light markings was weakest in the larva on the lichen-covered stick.

E. *The 3 dark, white-marked larvæ, including the darkest but* 1 *of the* 12, *with black twigs.*—All 3 larvæ were on the hawthorn branch, and were in the same condition as the above-described set (D). One was resting on a silken foot-hold, but this was probably accidental, as there was no trace of torpidity. All possessed the lichen-like appearance borne before hybernation.

F. *One of the* 3 *lightest larvæ, with lichen-covered sticks.*—The larva was resting on the muslin. It was doubtful whether anything had been eaten, but the larva readily moved on disturbance, and was not resting upon a foot-hold. It still remained one of the three lightest larvæ, and had not undergone any change during hybernation.

G. *Two of the 3 lightest larvæ, with black twigs.*—Both larvæ were healthy and irritable; they had evidently eaten. One was resting on the hawthorn branch and 1 on a black twig. They still remained very light, like that described above (F), and were quite unaffected by their dark surroundings during hybernation.

H. *The 2 larvæ—the brownish one and that with bluish-white spots—with lichen-covered sticks.*—It is improbable that anything had been eaten, and these larvæ did not appear to have emerged from hybernation. The one with bluish-grey marks was upon a lichen-covered stick: it was shrunken, and it appeared doubtful whether it would survive. The other was still attached to its foot-hold on the hawthorn branch, and had evidently not moved during the winter. It was very lichen-like, and entirely unchanged by its winter environment.

III. THE 11 QUERCIFOLIA LARVÆ WITH BROWN BRAMBLE-STEMS BEFORE HYBERNATION.

I. *Four of 7 uniformly brown larvæ, with lichen-covered sticks.*—All were healthy and had eaten freely: 3 were on the hawthorn branch, 1 on the muslin. All were distinctly brown.

J. *Three of 7 uniformly brown larvæ, with black twigs.*—One larva was dead, while 2 healthy ones had evidently eaten. Both were on the black twigs, and possessed the same dark brownish ground-colour with brown patches as the 4 last-mentioned larvæ (I).

K. *The 4 most distinctly spotted or lightest larvæ, with brown stems.*—One larva was dead, while 3 healthy ones had evidently eaten. All 3 were on the hawthorn-branch. This set still included the most distinctly white-spotted individuals of the whole 11. It was evident that no change occurred during hybernation.

IV. THE 14 QUERCIFOLIA LARVÆ UPON GREEN LEAVES AND SHOOTS OF THE HAWTHORN.

L. *Seven larvæ enclosed in a muslin bag containing a branch of the hawthorn.*—One larva was dead, 3 were on the branch, 2 on the muslin, while 1 became detached in removing the bag. All had left their foot-holds, with the doubtful exception of one on the branch. All 6 were healthy and irritable, and most of them had evidently fed;

in fact one of those on the branch was eating when the examination was made. The larvæ were on the whole darkish but very variable.

M. *Seven larvæ arranged as in the last set* (L). One larva was dead, 2 were on the branch, and 4 were on the muslin. All had left their foot-holds and were healthy and irritable. They had evidently eaten. Their appearance was similar to that of the set last described.

A complete history of the larvæ of each set, I to IV, subsequent to hybernation, will now be given, followed by an account of the careful comparisons of the whole which were made from time to time, all the larvæ being then placed on a uniform background of white paper.

I. THE QUERCIFOLIA LARVÆ ON BLACK TWIGS BEFORE HYBERNATION.

A. *The 3 chequered black-and-white quercifolia larvæ on black twigs throughout.*

April 7th.—Re-fed. Three black larvæ with small white patches. Unchanged when re-fed on the 10th: all on twigs.

April 16th.—Re-fed. Two larvæ on twigs, 1 on hawthorn: appearance unchanged, as also when re-fed on 20th, 23rd, 27th, and May 3rd: all larvæ invariably resting on the twigs.

May 7th.—Re-fed. One larva unaltered, while 2 had changed skin, and the white markings had become less bright. In one of these the old skin was still adherent anteriorly. This larva was removed to cylinder C (p. 344). The other older darker larva was sent to Lord Walsingham on May 11th.

May 11th.—Re-fed. The single remaining larva was at rest on twig; it was still black with white markings, and was unaltered when re-fed on the 17th, 22nd, and 25th, its position on the twig being noted on the two former dates. It was sent to Lord Walsingham on May 31st.

B. *The five darkest quercifolia larvæ with lichen-covered sticks during and after hybernation.*

April 7th. Re-fed. All 5 larvæ black, 3 of them with white spots.

April 10*th*. Re-fed. Four larvæ on sticks. Appearance unchanged.

April 16*th*. Re-fed. Four on sticks, 1 on hawthorn. Only 1 larva was now entirely black, the remaining 4 had acquired large white patches. Two larvæ, including the first-mentioned, were removed to cylinder B^1.

April 20*th*. Re-fed. All 3 on sticks, appearance unchanged and on sticks, as also when re-fed on the 23rd.

April 27*th*. Re-fed. Two on sticks, 1 on hawthorn. It was noted that in one of the larvæ the white marks were less developed than in the others.

May 1*st*. Re-fed. The last-mentioned larva had changed skin and the white markings were reduced to a single anterior pair and were quite small. The 2 others remained as before, and no further change was seen when the 3 larvæ were re-fed on the 3rd, 11th, 17th, 21st, and 25th. They were noted as at rest on the sticks on all these dates, except the first and last. The darkest larva was painted by Mr. Bayzand on May 19th, and is shown in Plate XVII, fig. 14. Of the two others, the one with the more intensely black ground-colour was painted by him on the 22nd, and is shown in fig. 15 of the same plate. Both these figured larvæ were sent to Lord Walsingham on May 25th, and the third was sent on May 31st.

B^1. *The two quercifolia larvæ separated from cylinder* B *on April* 16*th*.

April 16*th*. The larvæ were respectively entirely black, and black with white patches.

April 20*th*. Re-fed. Both on sticks, colour unchanged. Similar results were noted when re-fed on the 23rd and 27th.

May 1*st*. Both larvæ had apparently changed skin. The darker one had gained a pair of small white marks anteriorly. On May 5th the larvæ were brought back from London. No further change.

May 11*th*. Re-fed. The black-and-white larva was sent to Lord Walsingham. The single dark larva, on stick; appearance unchanged. Similar notes on the 17th, 22nd, and 25th, except that it rested on the hawthorn on the first-named date, and its position was not recorded on the last-named. The larva was sent to Lord Walsingham on May 31st.

C. *Three dark quercifolia larvæ (out of* 6) *on black twigs throughout.*

April 7th. Re-fed. Two larvæ dead. The third at rest on twig; black. When re-fed on the 10th it was on twig and unchanged.

April 16th. Re-fed. At rest on twig. It had changed skin and was black with a few whitish spots. When re-fed on the 21st, 23rd, 27th, and May 3rd it was unchanged, and on each occasion resting on a twig.

May 7th. Re-fed. At rest on twig; unchanged. A rather darker larva from cylinder A was added. Part of the skin of the previous stage was adhering to the anterior part. When re-fed on the 11th, 17th, 21st and 25th, these larvæ were unchanged in appearance. Upon all dates except the last it was noticed that they were both upon twigs. Both larvæ were sent to Lord Walsingham on May 31st.

II. THE QUERCIFOLIA LARVÆ ON LICHEN-COVERED STICKS BEFORE HYBERNATION.

D. *Four dark, white-marked quercifolia larvæ, including the darkest of* II, *on lichen-covered sticks throughout.*

April 7th. Re-fed. Four larvæ, of which one appeared to be unhealthy. All were darkish with large white patches.

April 10th. Re-fed. One larva had died, 3 upon sticks. Two had changed skin, 1 remaining unaltered, the other with a further extension of the white patches.

April 16th. Re-fed. Two larvæ upon sticks, 1 upon hawthorn. All were dark with large white patches, and 1 larva was very small.

April 21st. Re-fed. The 2 larger larvæ on sticks, the small one on hawthorn. The former dark grey and pale greyish-brown respectively; both with very large white patches. The small larva was brownish-grey with pale marks. When re-fed on the 23rd all were on sticks and unchanged, as also on the 26th, except that the small larva was on the hawthorn.

May 3rd. Re-fed. The pale greyish-brown larva had changed skin and was now a darker blackish-brown, with large pale markings. The other larvæ were unaltered.

May 11th. Re-fed. Two on sticks, the third, the large

dark grey larva, having been sent to Lord Walsingham on this date. The remaining large larva was dark brown with large yellowish markings; the small larva had changed its skin and was bluish-grey. The larvæ were re-fed on the 17th and 22nd, when they were on sticks and unchanged in appearance. The larger larva appeared to be unhealthy on the 22nd and died on the 23rd.

May 15th. Re-fed. The colour of the small larva was unchanged, as also on June 1st and 7th. It continued to grow slowly without further change, and finally spun up on July 28th.

E. *Three dark, white-marked quercifolia larvæ, including the darkest but one in* II, *on black twigs during and after hybernation.*

April 7th. Re-fed.

April 10th. Re-fed. All 3 larvæ on twigs. Two larvæ had changed skin, but the appearance of all 3 remained the same, viz. black with very conspicuous white markings. They were unchanged and at rest on the twigs when re-fed on the 16th, 21st and 23rd.

April 26th. Re-fed. All on twigs. The dark colour of the larvæ appeared to have become more distinctly grey—dark grey in two cases, grey in the third. As before, the dark shade was combined with white markings.

May 2nd. One dark grey and white larva had changed skin and was blackish and white.

May 11th. Re-fed. The largest larva with a rather darker ground-colour than others was sent to Lord Walsingham. The 2 remaining larvæ on twigs; both blackish and white. Re-fed again on the 17th, when they were on the twigs and unchanged. The smaller larva did not seem healthy and had not grown like the other. The larger larva, the darkest of all in set II, was painted on May 17th, and is represented in Plate XVIII, fig. 4.

May 22nd. Re-fed. Two larvæ on twigs. The appearance unchanged, but neither looked healthy. The larger larva died on the 25th and the smaller on June 1st.

F. *One light quercifolia larva on lichen-covered sticks throughout.*

April 7th. Re-fed. White and pale grey.

April 10th. Re-fed. On stick. The larva had changed its skin, and had become white with markings of two

shades of brown. It was re-fed on April 16th, 21st (markings of two shades of pale brown), and 23rd, and was always found on sticks with appearance unchanged.

April 26th. Re-fed. On stick. The larva was now white with grey and brownish markings. On May 3rd it was re-fed, the appearance being unchanged.

May 7th. The larva had changed skin; the white parts had become yellower. It was re-fed on May 11th, 17th, and 22nd, and was noted as at rest on stick on the 11th and 22nd. It remained to the end of a yellowish-white with markings of grey and brown.

May 25th. The larva was painted by Mr. Bayzand and is shown in Plate XVIII, fig. 3. It was sent to Lord Walsingham on the same date.

G. *Two light quercifolia larvæ on black twigs during and after hybernation.*

April 7th. Re-fed. Both lichen-like.

April 10th. Re-fed. Both at rest on twigs. One had changed skin, and the greyish markings had become rather darker. Both were at rest on twigs with appearance unchanged when they were re-fed on the 16th.

April 21st. Re-fed. Both on twigs. One larva was white with pale grey markings, the other creamy-white with markings of a brownish-grey. Unchanged and on twigs when re-fed on the 23rd.

April 26th. Re-fed. Both on twigs. The white colour of the larva first mentioned on the 21st had gained a faint bluish tinge. The other larva unchanged.

May 5th. Re-fed, after having been brought back from London. The creamy-white larva had changed skin and was rather paler in tint. Both were on twigs and unchanged when re-fed on the 11th. The creamy-white larva was painted by Mr. Bayzand on the 14th, and is shown in Plate XVIII, fig. 1.

May 17th. Re-fed. Both on twigs. One larva large and pale creamy-white with greyish-brown markings. The other much smaller, white with bluish-grey markings, but with tints duller than they were formerly. It had not grown much, nor changed its skin. Both larvæ were unchanged in appearnce, and were resting on twigs when they were re-fed on the 22nd. The creamy larva was sent to Lord Walsingham on May 25th. The smaller bluish-

grey larva was painted on May 28th, and is shown in Plate XVIII, fig. 2. It was sent to Lord Walsingham on May 31st.

H. *The brownish quercifolia larva and the larva with bluish-white marks on lichen-covered sticks throughout.*

April 7th. Re-fed. One larva dead; the other grey and white. The larva was re-fed on the 10th, 16th, 20th, 23rd, 26th, and on May 3rd. Its appearance remained unchanged. On all these dates except the last it was noted that the larva was at rest on the sticks. On May 5th it was dead.

III. THE QUERCIFOLIA LARVÆ ON BROWN BRAMBLE-STEMS BEFORE HYBERNATION.

I. *Four uniform quercifolia larvæ on lichen-covered sticks during and after hybernation.*

April 7th. Re-fed. All 4 dark brown, 2 rather darker than the others.

April 10th. Re-fed. All 4 at rest on sticks: 2 unchanged, and 2 had changed skin, becoming respectively dark grey with white patches and blackish-grey with white patches and brown marks.

April 14th. Re-fed. Larvæ on sticks. The larger ones unchanged. The 2 smaller had now changed skin, becoming respectively very dark blackish-brown with white marks, and dark brown mottled with pale grey.

April 16th. Re-fed. Larvæ on sticks. The 2 larger darker larvæ were now placed in another cylinder. The two remaining were respectively—mingled shades of dark and light grey with brown patches, and a uniform grey with large white patches. These 2 larvæ were re-fed on April 21st and 23rd without change. They were always at rest on the sticks.

April 26th. Re-fed. Both larvæ on sticks. One larva retained same appearance, grey with brown patches; the other was of a pale brownish-grey with paler marks.

May 1st. The latter larva had become of a much darker brownish-grey with brown and pale marks. On May 3rd they were re-fed, and both were on sticks: appearance unchanged.

May 11th. Both larvæ on sticks. The last described

larva unchanged. The other had now also darkened, becoming blackish-grey with paler marks. The larvæ were re-fed on May 17th, 21st, and 25th, without further change in appearance. It was noted that they were at rest on the sticks on the 17th and 21st. On May 31st both larvæ were sent to Lord Walsingham.

I[1]. *The two larger darker quercifolia larvæ separated from* I *on April 16th.*

April 16th. One larva was now blackish-brown with white marks, the other very dark grey with white and brown marks.

April 21st. Re-fed. One larva on sticks, 1 on twigs of hawthorn. Appearance unchanged, as also on April 23rd and 26th, when they were re-fed and both found on sticks.

May 1st. The dark grey larva had changed skin and become blackish-brown with pale and brown spots. On May 3rd they were re-fed and found unchanged in appearance on the sticks.

May 11th. The larva with pale and brown spots was sent to Lord Walsingham. The remaining larva was at rest on stick, and blackish with two pale marks. It was re-fed on May 17th (on stick) and 25th. On the 31st it was sent to Lord Walsingham. There was no further change in its appearance.

J. *Two uniform quercifolia larvæ on black twigs during and after hybernation.*

April 7th. Re-fed. One larva purplish-brown and black, the other had changed skin and was black with small white patches and minute brown points. Both were resting on twigs and unchanged in appearance when re-fed on the 10th.

April 16th. Re-fed. Both on twigs. The purplish-brown and black larva appeared to be even darker, the other unchanged. Both were on twigs and unaltered when re-fed on 21st and 23rd.

April 26th. The black larva with small white patches and minute brown points was dying.

April 27th. The last-mentioned larva was dead. The other purplish-black larva was at rest on a twig.

May 1st. The larva had changed skin, and was black with

a pair of small white marks. It was on a twig unchanged when re-fed on the 3rd.

May 25th. The larva was sent to Lord Walsingham. Mr. Bayzand completed his painting of it on the 11th, and the larva is represented on Plate XVIII. fig. 6.

K. *Three of the more spotted or lighter quercifolia larvæ on brown bramble-stems throughout.*

April 7th. Re-fed. One larva brown, 1 brown with few white marks. The third grey-brown one had changed its skin and become brown-grey with white patches.

April 10th. Re-fed. Larvæ resting on stems. The brown larva had become brown and very dark grey with white patches. The other two remained the same.

April 16th. Re-fed. Larvæ resting on stems. The brown larva with a few white marks had become darker, and was now black along the median dorsal area and very dark brown on the sides: the white patches large. The two other larvæ remained the same.

April 20th, 23rd, and *27th.* The larvæ were re-fed on each of these dates, and were invariably found upon the stems. The appearance was unchanged.

May 1st. One of the brownish-grey larvæ changed its skin, becoming rather browner in shade.

May 3rd. Re-fed. Three larvæ resting on stems. Appearance unchanged.

May 11th. Re-fed. Two larvæ on stems. Appearance unchanged. Mr. Bayzand finished painting the brownest larva which is represented on Plate XVIII, fig. 5. The brownish-grey larva sent to Lord Walsingham for preservation. Another brown one was sent on the 12th.

May 17th, 22nd, and *25th.* The single remaining larva was re-fed on each of these dates. It was noted as at rest upon a stem except on the 25th. Its appearance was the same on all occasions, viz. blackish with pale grey marks and brown spots. It was sent to Lord Walsingham on May 31st.

IV. THE QUERCIFOLIA LARVÆ ON LEAVES, TWIGS, OR SHOOTS OF THE HAWTHORN THROUGHOUT.

L

April 7th. Re-fed. One brown larva dead. Appearance of others unchanged, viz. 3 brown and 2 blackish-brown.

April 10th. Re-fed. Three larvæ unchanged. One brown and 1 blackish-brown larva had changed skin and become blackish-grey with large white patches.

April 16th. Re-fed. The two largest larvæ last described removed to another cylinder, L^1. The three others unchanged. One of two smaller brown larvæ appeared unhealthy.

April 20th. Re-fed. One larva had changed skin and grown much. Of the others, neither of which had changed skin, one was dead and one appeared to be dying.

April 23rd. The single healthy larva was brownish-black with white marks.

April 27th. The small larva was dead. The appearance of the other unchanged, as also on May 3rd and 11th, when it was again re-fed. On May 17th the larva had died.

L^1

The two larvæ separated from L on April 16th were re-fed and examined on April 21st, 23rd, and 27th, the appearance remaining the same throughout, viz. dark grey with large white patches. On May 3rd the larger of the two larvæ looked sickly; on May 5th it was dead and the smaller one seemed unhealthy. The latter died on May 7th.

M

April 7th. Re-fed. Five larvæ alive, all greyish-brown. One of two unhealthy-looking larvæ had died.

April 10th. Re-fed. Four larvæ unchanged; the fifth had changed skin and had developed larger white patches.

April 16th. The 2 largest larvæ were now separated and placed in another cylinder, M^1. The remaining 3 were brownish-grey, 2 of them with pale patches. The smallest was browner than the others and appeared to be unhealthy.

April 21st. Re-fed. The last-mentioned larva was dead; the others unchanged in appearance although one had changed skin during the interval.

April 23rd. Re-fed. Unchanged.

April 27th. Re-fed. One larva had become darker, viz. blackish-grey with white patches. The larvæ were re-fed and compared on May 3rd, 11th, and 17th, without change in appearance.

May 22nd. Re-fed. The brownish-grey larva had died, the darker one unchanged.

May 25th. The last-named larva had died. Neither of these larvæ had grown large.

M[1]

The 2 largest larvæ separated from M on April 16th. Both were greyish-brown with distinct white patches.

April 21st. Re-fed. Unchanged. The larvæ were also re-fed on the 23rd, 27th, May 3rd, 11th, 16th, and 22nd, and examined on each occasion. The appearance remained the same throughout. On the 25th both were sent to Lord Walsingham.

Second General Comparison after Hybernation.

April 27th, 1894. The larvæ were carefully compared and were all placed upon a background of white paper. Nearly all of them were sluggish, probably preparatory to the last ecdysis.

I. The Quercifolia Larvæ with Black Twigs before Hybernation.

A. *The three chequered larvæ with black twigs.*—These larvæ were unchanged and still remained the lightest of the whole of series I. Hence the black twigs had produced no effect during hybernation.

B. *The five darkest larvæ enclosed with lichen-covered sticks during hybernation.*—One was very dark, the darkest of the whole group; 1 was dark with faint light spots; 3 were black chequered with white markings, which however were less developed than in A.

It is possible that these last-mentioned three larvæ may indicate some susceptibility to the effect of the lichen-covered sticks after they were enclosed upon the tree and before the commencement of hybernation.

C. *The six dark larvæ with black twigs.*—Only one larva was alive, and this was dark with very faint dull white spots.

All the above described 9 larvæ were healthy and well up to the average size.

II. The Quercifolia Larvæ with Lichen-covered Sticks before Hybernation.

D. *The four dark, white-marked larvæ, with lichen-covered sticks.*—Three larvæ were alive and unchanged: one was very small.

E. *The three similar larvæ, with black twigs.*—These also were practically unchanged and like D. One of these was now the blackest larva, but the smallest in D was almost exactly the same. It is possible that some *very slight* effect was produced by these black twigs before hybernation.

F. *One of the three lightest larvæ with lichen-covered sticks.* —The larva was quite unchanged.

G. *Two of the three lightest larvæ with black twigs.*—No effect had been produced by the black surroundings. The bluish-grey larva remained very distinct.

H. *Two larvæ with lichen-covered sticks.*—The brownish larva had died. The other still remained the darkest individual of the lighter part of the group (F, G, H) as it was when the arrangements for hybernation were made.

Comparing these two important groups I and II as a whole, it was seen that the lightest larva of I (in A) was almost precisely similar to the darkest of II (in E):—in fact they could not have been distinguished as regards the size of the light patches. On the other hand, the larva in I was healthy and of the average size, while that in II was rather small. The smallest in D was not considered in this comparison, as it had grown but little and was a stage behind the others. Its light patches, although very dull and grey, were almost exactly the same size as those of the darkest larva in D. The remaining nine larvæ in II were all large and healthy, and much lighter than the lightest larva in I.

III. THE QUERCIFOLIA LARVÆ WITH BROWN BRAMBLE-STEMS BEFORE HYBERNATION.

Comparing these as a whole with sets I and II it was obvious that the lightest of them was distinctly darker than the darkest of the group just described (II) and exposed to lichen before hybernation. The larvæ were perhaps as dark as those in group I, exposed to Turkish oak before hybernation, but they were not so black, and, except in two larvæ, the light markings were less white, being greyish and clouded over.

I. *The four uniform dark larvæ with lichen-covered sticks.* —Two larvæ were very dark with a dull blackish ground-

colour. The two others were not so dark and bore brown points and patches, which tended to fuse at their edges with the dark greyish ground-colour.

J. *The three similar larvæ with black twigs.*—Only one larva was alive, and this was rather darker than the darkest of the set just described (I), having a dull blackish ground-colour. One dead larva had a very black ground-colour with brown dorsal points and distinct although small white patches. It is probable that some slight effect was produced by the black twigs just before hybernation began.

K. *The four lightest and most distinctly spotted larvæ, with brown twigs.*—Three larvæ were alive. The smallest one possessed the blackest ground-colour and the whitest patches of any in the whole series (III). The other two closely resembled the two lighter larvæ in I.

IV. THE QUERCIFOLIA LARVÆ UPON GREEN LEAVES AND SHOOTS OF THE HAWTHORN.

L, M. There was no distinction between the two lots. The larvæ, as before hybernation, presented a great range of variation, but the ground-colour was upon the whole greyish. The lightest individual was rather lighter than the darkest of those upon lichen before hybernation (II), while the next in order was about the same as the darkest of II. Four others were rather less light, while a fifth was a distinctly dark form. Hence the set was upon the whole intermediate between I and II and distinctly lighter than III.

April 28th. The length of all those larvæ which had ceased to feed preparatory to a change of skin was about 56·0 mm. A few days later the cast skins were examined, and were seen to possess the white markings as well as the dark ground-colour. Hence these characters are in part, if not entirely, cuticular in position.

THIRD GENERAL COMPARISON OF THE LARVÆ MADE AFTER HYBERNATION, MAY 7TH.

I. THE QUERCIFOLIA LARVÆ WITH BLACK TWIGS BEFORE HYBERNATION.

A. *The 3 chequered larvæ with black twigs.*—Two larvæ were dark, and 1 black chequered with white markings, which were larger than those of any other larvæ in I, but

much smaller than any in II, except the small larva in E and 1 in D.

B. *The 5 darkest larvæ with lichen-covered sticks.*—Three larvæ, 1 of which was changing its last skin, were black chequered with white markings, which were not quite so large as those of the larva in A. Two larvæ were very dark and unspotted.

C. *The single dark larva with black twigs* was changing its last skin, and was still dark.

Hence probably no effect had been produced by the surroundings to which the larvæ had been exposed since hybernation.

II. THE QUERCIFOLIA LARVÆ EXPOSED TO LICHEN-COVERED STICKS BEFORE HYBERNATION.

D. *The 3 dark, white-marked larvæ with lichen-covered sticks.*—Two larvæ were large in the last stage. One of them became much darker after changing its last skin, but still remained black with light markings. The effects of their dark and light tints were more brownish and yellowish, and on the whole darker than those of the 2 large larvæ in E. In fact, a comparison of D and E did not support the conclusion that the larvæ were sensitive to their environment after hybernation.

The small larva in D which had lagged behind the others had changed its skin and was rather lighter. It was still in an earlier stage than any of the others, but apparently healthy.

E. *The 3 similar larvæ with black twigs during and since hybernation.*—Two larvæ were large in the last stage and remained black-and-white. The third larva was smaller and had been injured. It was probably unable to change its skin in consequence.

F. *One of the lightest larvæ with lichen-covered sticks throughout.*—This larva was in last stage, and its light markings had become much darker in tint, being of a yellowish-brown colour.

G. *Two of the lightest larvæ with black twigs during and since hybernation.*—The lighter of the 2 remained about as in the previous stage; the other, the bluish-grey larva, had not yet changed its last skin, but was apparently

rather darker. These 2 larvæ were upon the whole somewhat lighter than those in F and H.

H. *The larvæ with bluish-white spots exposed to lichen-covered sticks throughout.*—This larva was dying. It was now lighter than the larva in F, but this difference was entirely due to changes in the latter.

III. THE QUERCIFOLIA LARVÆ WITH BROWN BRAMBLE-STEMS BEFORE HYBERNATION.

I. *The 4 uniform larvæ with lichen-covered sticks during and since hybernation.*—Three larvæ were in the last stage, 2 of them brownish with small white spots like those in K, but with the ground-colour darker. The 3rd was considerably darker. The 4th larva was changing its skin. It possessed a deep brownish-black ground-colour, which appeared to be overspread with grey.

J. *The uniform larva with black twigs during and since hybernation.*—The larva was very large in the last stage, and very uniformly dark and unspotted, although rather less black than those which had been exposed to black twigs before hybernation (I).

K. *The 3 spotted or lighter larvæ upon brown stems throughout.*—Two larvæ in the last stage were dark brownish with small light patches. The third, in the last stage but one, was more black-and-white, resembling the larvæ which had been exposed to black twigs before hybernation (I).

Compared as a whole the larvæ of I were blacker than III, although these were very dark. The latter were distinguished by greyish-brown shades absent from the ground-colour of I. The light patches, when present, were distinguished in III by a brownish tinge, and were more clouded and less distinct than in I.

Comparing carefully the darkest larva of II (viz. the 4 darkest in D) with those of I, it was seen that the pale patches were of the same size as those of the larvæ in which they were most developed of all exposed to black twigs (viz. the lightest larvæ in A). But although the patches were of the same size, those of the former were yellowish-brown and clouded, and those of the latter white. The ground-colour of the larva in II was, however, much lighter, being a brownish-black, than that of the lightest larva in I. Hence the darkest larva in II was distinctly darker

than the lightest in I as regards its pale patches, but distinctly lighter as regards its ground-colour. And this comparison only holds for a single exceptional dark larva. All others in II were far lighter than any in either I or III.

IV. THE QUERCIFOLIA LARVÆ EXPOSED THROUGHOUT TO THE LEAVES AND SHOOTS OF THE HAWTHORN.

Only 6 larvæ remained alive, and of these but 2 were in the last stage. Four larvæ possessed a ground-colour very like that of series III, but the white patches were far larger, and tended to spread as a greyish shade down the sides. The light patches were, however, much smaller than in the larvæ of series II. One of the smallest larvæ was dark with very small white patches, like one of the darkest of III. A dying larva, unable to change its skin, was intermediate between this latter and the 4 first-mentioned larvæ.

The colours of these larvæ in series IV seem to have been influenced by the brownish and greyish twigs and shoots of the hawthorn.

LAST GENERAL COMPARISON OF THE QUERCIFOLIA LARVÆ AFTER HYBERNATION, MAY 25TH.

Of series I it was recorded that the single larvæ in A and 2 in B were black with conspicuous white markings; while 1 in B, 1 in B^1, and 2 in C were dull black with only a pair of small inconspicuous white markings.

Of series II nothing is recorded which is not contained in the description of cylinders D to G.

Of the 4 larvæ then remaining in III it was noted that the larvæ in K much resembled the black-and-white ones in A and B; while the 3 in I and I^1 were dull blackish with the pale markings very inconspicuous.

Only 2 larvæ remained alive in IV. The brownish ground-colour of both was much clouded and overspread with grey, and the pale patches tended much to spread downwards, becoming grey and clouded especially towards the ventral surface.

TRANSFER EXPERIMENTS WITH THE LARVÆ OF AMPHIDASIS BETULARIA IN 1896.

A female moth, captured at Oxford, laid a small batch of eggs, which provided the material for the following

experiments, undertaken in order to attempt to ascertain the susceptible stages of this highly-sensitive larva.

The experiment started on May 10th, when the young larvæ were first fed upon the leaves of *Populus nigra*, all dark twigs and branches being at first rigidly excluded. It must be remarked, however, that for a few days after May 10th the leaves had only just expanded and were somewhat brownish. Various sets of larvæ were withdrawn from the stock, and the transference experiments were then conducted in the following manner. All measurements were taken when the larvæ were stretched and straight. A convenient summary of the results of the following experiments will be found in the table on page 319.

A. *A. betularia.*

May 16th. Twenty *betularia* larvæ at the end of the 1st stage, and nearly all changing the first skin, and 5·0 mm. long, were transferred from green to black surroundings (the twigs of the Turkish oak). Up to this date the green leaves of *P. nigra* upon which they had been placed on May 10th were somewhat brownish, because the buds had only just opened.

May 20th. The larvæ were examined from time to time between the 16th and this date, and had always been found upon the leaves and never upon the twigs. On the 20th every single larva was found upon the leaves. They even avoided the stem of the food-plant. Ten larvæ changing the 2nd skin, and 8·5 mm. long, were re-transferred into green surroundings (A^1). The 10 remaining larvæ had attained various degrees of development in the 2nd stage, 3 being at the end of it, but not yet changing the 2nd skin. From this date to the 29th these 10 larvæ were fed upon Balsam Poplar, but from the latter date onwards upon *P. nigra*.

May 25th. Only 1 on the twigs, the rest on the leaves. One larva was changing the 2nd skin, and none had yet entered the 3rd stage.

May 29th. Two larvæ on the twigs, and both these were changing the 3rd skin. Of the rest 1 was changing the 3rd skin and 12·5 mm. long, and 2 had just changed it. These 5 were re-transferred to green surroundings (A^2). The remaining 5 were in the 3rd stage, 4 nearly at the end of it, and 1 very small.

May 31st. Only 1 on twigs. Four changing 3rd skin,

the 5th still small in the 3rd stage. The black twigs were removed at this date, and the 5 larvæ by this means re-transferred to green surroundings.

June 2nd. Four in 4th stage, and 1 nearly at the end of 3rd stage. Four distinct medium brown colour; 1 very black.

June 5th. One changing 4th skin and light reddish-brown; 2 in 4th stage, both darkish brown; 1 at beginning of 5th stage and medium brown; the 5th small one was only 9·0 mm. long.

June 14th. One small in 6th stage, and dark brown with distinct grey markings prominent on it; 1 changing 5th skin and light brown with ventral surface rather greenish; 2 at end of 5th stage, 1 intermediate and 1 similar to but rather darker than the larva changing its skin.

June 20th. Four in 6th stage, 2 dark, overspread with greyish, 1 green with brown dorsal line and lateral patches, 1 dark form becoming greenish on the sides.

June 26th. One dark larva mature and removed.

July 2nd. The green larva and the one with greenish sides mature and removed. The remaining larva was very dark, with distinct sharply-marked pale yellowish spots on its sides, and one on each side of the dorsal surface of each segment.

July 12th. The larva described above had been accidentally drowned.

CONCLUSIONS.

The effect of the dark surroundings is evident. The green environment of the three last stages was doubtless the cause of the greyish tint, the greenish sides, and the yellowish spots on the 3 dark larvæ. In the case of the 4th larva the effects of the latter surroundings were predominant, although the larva still retained strong traces of its earlier environment in the brown markings. Comparing this result with that of A^1, the relative unimportance of environment in stage II becomes clear.

A^1. *A. betularia.*

May 20th. The 10 *betularia* larvæ re-transferred from black into green at the end of the 2nd stage, changing the 2nd skin, and 8·3 mm. long.

From this date to the 29th the larvæ were fed upon Balsam Poplar, and then again upon *Populus nigra*.

May 25th. Most of the larvæ were changing the 3rd skin, and all were apparently dark.

May 29th. All had changed the 3rd skin except 2, which were changing it. All were dark brown except the 2 latter, which, together with 1 which had just changed, were light brown. The average length was 14·25 mm.

June 2nd. Four were changing the 4th skin; 5 were at various points in the 4th stage, with an average length of 20·75 mm.; 1 was in the 5th stage. All were brown, although not very dark.

June 5th. Four were changing the 5th skin, 33·0 mm. long, and 1 at end of 5th stage. The latter was medium brown, the others 3 light brown and 1 green with light brown markings. The remaining 5 were much smaller, being all in the 4th stage, 3 dark brown and 2 light brown.

June 14th. Five were nearly mature, 2 green sprinkled with distinct greyish dots much more numerous in the larger larva, which was practically mature and 55·0 mm. long. The ground-colour of this latter larva was bright green, the dorsal tubercles dark grey. Of the other 3 large larvæ, 1 was very light grey, almost whitish with darker dots and mottling, 2 were much darker, blackish rather than brown, with light grey markings. The largest of the set of smaller larvæ was changing its 5th skin and greenish-brown, 1 smaller in the 5th stage was green with dorsal brown line, 1 smaller still, chocolate brown. Two larvæ were still quite small, viz. 12·25 mm., and probably still in the 4th stage. Both were dark brown, but they appeared to be unhealthy.

June 15th. The greenest, the whitish, and 1 dark larva had become mature and were removed.

June 20th. One green larva mature and removed. Two in 6th stage, 1 dark with greyish markings not greatly developed, 1 intermediate, brownish-green; 1 changing 5th skin, green, 2 in 5th stage and lightish brown.

June 22nd. The dark larva in 6th stage mature and was removed. Two larvæ in 6th stage, 1 on green side of intermediate, viz. green clouded over but not entirely obscured by brown, 1 distinct green with a brown dorsal line and a little brown on the sides. Of the 2 smaller larvæ, 1 was in the 5th stage and brownish-green, 1 in the 4th and light brown.

June 26*th*. The brownish-green larva in the 5th stage was dead. The 2 large ones as last described.

July 2*nd*. The greenish intermediate larva had become mature and was removed. The distinct green one was very large, being 64·6 mm. long. The green ground-colour was somewhat dull, and the brown dorsal line broad but not dark. The remaining larva was in the 5th stage and intermediate.

July 12*th*. The last-mentioned larva was dead. The other had pupated.

CONCLUSION.

The effect of a dark environment during the 2nd stage alone, although slight, is very remarkable. The grey which overspread the green forms may be compared to the grey patches on the dark form in this and so many of the other experiments.

A². *A. betularia.*

May 29*th*. The 5 *betularia* larvæ re-transferred to green surroundings after they had been in black during the 2nd and 3rd stages.

May 31*st*. All 5 larvæ were advancing in the 4th stage, and all dark or distinct brown.

June 2*nd*. Two larvæ were changing the 4th skin and 22·0 mm. long; the 3 others advancing in the 4th stage. Appearance unchanged.

June 5*th*. One larva changing 5th skin and medium brown; 2 half-grown in 5th stage and 1 nearly at end of it; 2 dark brown, 1 of the larger pair light brown. The 5th larva in 4th stage and dark brown.

June 14*th*. Four approaching the end of the 6th stage; 2 very black and 2 similar, except that the ground-colour was overspread with light grey, in one case slightly, in the other thoroughly. The latter was nevertheless a darkish larva. The 5th larva was changing the 5th skin, and green with a brown median dorsal line.

June 15*th*. One dark larva had become mature and was removed.

June 20*th*. One dark larva mature and removed. The remaining 3 larvæ were all in the 6th stage. The grey colour of one of the dark larvæ was still very distinct. The brown dorsal line was pronounced upon the green larva.

June 26th. The 2 dark larvæ mature and removed. The 5th larva had now became a typical and distinct bright green form, the brown dorsal line having almost disappeared.

July 2nd. The green larva mature and removed.

CONCLUSIONS.

This is a deeply interesting little set, showing the effect of the dark surroundings persisting unaltered in the 2 larvæ which were first to pupate, the green environment producing some effect in the greyness overspreading the next 2, and predominating altogether in the last.

B. *A. betularia.*

May 20th. The 51 *betularia* larvæ remaining in the stock, with green leaves and shoots of *Populus nigra*, were carefully examined. Two larvæ had just entered the 3rd stage, having changed the 2nd skin, 5 were small in the 2nd stage, while all the rest were changing the 2nd skin, and thus at the end of the 2nd stage. Twenty of these latter were transferred to a cylinder (B^1) with an abundance of black twigs of the Turkish oak, while the remainder were put back into the green environment. From this date to the 25th all the larvæ were fed on Balsam Poplar.

May 25th. Thirty larvæ counted at this date. Of these, 15 changing the 3rd skin were transferred to a cylinder (B^2) with black twigs. The remaining larvæ were smaller, but even in the 3rd stage a small proportion of green individuals had begun to appear among the brown. All the larvæ were fed on *Populus nigra* from this date (May 25th) onwards.

May 29th. The 15 larvæ remaining in the green environments were mostly at the end of the 3rd stage and many were changing the 3rd skin. They were mostly light brown but some were green.

June 2nd. Six larvæ had reached the end of the 4th stage, although they were not changing their skins. Of these 5 were green with slight traces of brown, while the 6th, although green, retained a larger amount of the darker shade. Six larvæ were smaller, having reached various points in the 4th stage. Of these 2 were green with slight traces of brown, while four were brownish-green or light greenish-brown. Three larvæ were still in the 3rd

stage, and of these the smallest was dark brown while the other 2 were light greenish-brown.

June 3rd. The five largest larvæ were changing the 4th skin, and were placed in a cylinder (B^3) with black sticks. Their colour was as described on June 2nd, and their length 20·5 mm. The colours of the remaining 10 larvæ had not altered.

June 5th. Only 9 larvæ were found. Two larvæ were in the 5th stage and bright green. Five were more or less advanced in the 4th stage, and were distinctly green with a variable degree of development of brown patches. Two were much smaller in the 4th stage and light greenish-brown in colour.

June 20th. Three larvæ were large in the 6th stage, and all very bright green with only a trace or no trace at all of a brownish tint along the median dorsal line. The other 6 larvæ were not noted on this date.

June 26th. Only 8 larvæ were found. Two of the largest green larvæ had become mature, and were removed for pupation. The remaining 6 were of various sizes, but all were bright green except one.

July 2nd. One green larva was mature and was removed. Three were in the 6th stage, 2 bright green, one of them with a little brown on the sides and a brown dorsal line; the 3rd was intermediate, with a brown dorsal line, and green and brown patches alternating on the lateral surfaces. One was changing the last skin and one in the 5th stage, both bright green.

July 12th. One green larva mature and removed. The 2 small ones were dead. Of the two remaining larvæ in the 6th stage 1 was bright green and 1 intermediate.

CONCLUSIONS.

The only point which calls for remark is the occurrence of a single intermediate larva. This was a probable result of the large numbers of the young larvæ in a single cylinder: so that some effect in a specially susceptible individual followed from the presence of other young brownish caterpillars.

B^1. *A. betularia.*

May 20th. The 20 *betularia* larvæ changing the 2nd skin transferred from green leaves and shoots to an environment

of black twigs. The larvæ were of a very uniform length of 8·5 mm.

May 25th. Six were found on the black twigs, the rest on the leaves. Ten larvæ, all about 140 mm. long, at the end of the 3rd stage, and mostly changing the 3rd skin, were transferred to green surroundings (C). The remaining larvæ were fed on Balsam Poplar from May 20th until the 29th. Green forms had begun to appear among the brown.

May 29th. Only 1 on black twigs. Seven larvæ were at the beginning of the 4th stage, 6 dark and 1 greenish. Two were changing the 3rd skin and 1 nearly mature in the 3rd stage.

June 2nd. Four larvæ on the twigs. Two were changing 4th skin, and 8 at various degrees of development in the 4th stage. All brown and the largest larvæ very dark brown.

June 3rd. Only 1 on the twigs. Two had now changed 4th skin on the 2nd, and were transferred to green surroundings (C^1): 1 was very black, the other a medium brown.

June 4th. Three on twigs. All larvæ in 4th stage, all brown of various shades: those on the twigs very black.

June 5th. Only 1 on twigs and that a light brown one. One light brown larva changing 4th skin and transferred to green surroundings (C^1). Five in the 4th stage, including 1 dark brown larva which had just died, 1 in 3rd stage. All brown (more or less dark).

June 7th. Two on twigs, dark and medium brown. The latter was changing its 4th skin and was transferred to green (C^1), together with another dark brown larva which had just entered the 5th stage. The remainder were as last described, and all were advancing in the 4th stage.

June 14th. Two were on the twigs; both in the 5th stage, one dark greyish-brown and the other dark chocolate-brown. Two were on the leaves, both in the 5th stage and greyish-brown, lighter than the former two.

June 20th. Two large in the 6th stage and very dark.

June 26th. Four in the 6th stage and all very dark indeed.

July 2nd. Two of the dark larvæ had become mature and were removed. The remaining larvæ were very black and nearly mature.

July 12th. The 2 last larvæ had forced their way through the hole in the plate and were drowned. Their appearance had not changed, and it is probable that they had become mature and began to wander.

CONCLUSIONS.

In the final result we probably see the full and characteristic effect of the black twigs unmodified by the green environment in which the two youngest stages were passed.

B². *A. betularia.*

May 25th. Fifteen *betularia* larvæ transferred from green to black; all changing the 3rd skin and 14·0 mm. long. Some were becoming greenish, but most were brown.

May 29th. All examined: the colour varied very greatly, but none were altogether green although there was much green ground-colour on some. All were in the 4th stage; 1 only on the black twigs and that happened to be a particularly green one. Many light brown and many dark brown.

June 2nd. Five on twigs, 3 in the 5th stage, 1 changing 4th skin, and 1 nearly at end of 4th stage. The latter and 1 in the 5th stage dark greenish-brown, the remaining 3 very dark brown. On the leaves and green stems there were in the 5th stage, 1 green, 3 light brownish-green, and 2 light brown (1 slightly greenish); in the 4th stage, 2 brownish-green and 2 medium brown.

June 5th. On the black twigs there were 8 larvæ, 7 in the 5th stage (3 of them changing the 5th skin), 5 dark brown, 1 bright green (changing skin), and 1 brownish-green (half-grown in stage); 1 in 4th stage and brownish-green. On the light brown stem of *P. nigra* was a single larva which harmonized with it very exactly. On the leaves were 5 larvæ, 2 small in the 5th stage and light brown, 3 in the 4th, 1 dark (changing the 4th skin), 1 brownish-green, and 1 greenish-brown.

June 14th. Six larvæ in the 6th stage were on the twigs and very deep black, some of them with a small amount of greyish markings. One similar larva on green: 1 larva in the 6th stage on green was of a uniform dull light grey tint: of 2 larvæ in the 5th stage, 1 was changing the 5th skin and light brown overspread

with grey, 1 smaller and darker with less grey. Two smaller larvæ, probably in the 4th stage, or perhaps at the beginning of the 5th, were respectively lightish and darkish-brown.

June 15*th*. One of the darkest larvæ had become mature and was removed.

June 18*th*. One of the darkest larvæ become mature and was removed.

June 20*th*. Two very dark larvæ mature and removed. One very small one dead. Of the 6 in the last stage, 4 were very black, in 3 cases overspread with dull greyish patches; 1 was greyish on the dorsal surface, lighter grey elsewhere; the 6th and smallest somewhat resembled that last described.

June 26*th*. All had become mature except that last-mentioned, which had become a dark brownish-black.

July 2*nd*. No further change.

July 12*th*. The larva had become mature and was removed.

CONCLUSIONS.

The power of the black surroundings is evident, the influence of the green being only seen in the occasional greyness on the black larvæ, and especially in the one larva which was entirely grey. The brownish shade of the larva which was the last to reach maturity is unusual on the twigs of Turkish oak. These probable effects of the green on the larvæ which had been longest exposed to the influence of black (being the last to pupate), are contrary to the results observed in the other experiments.

B^3. *A. betularia.*

June 3*rd*. Five *betularia* larvæ in green surroundings up to the end of the 4th stage were transferred to black. They were changing the 4th skin and 20·5 mm. long.

June 5*th*. One larva, a green one, was on a black twig, the others on the leaves. Four were brownish-green and 1 medium brown. All were advancing in the 5th stage and about the same size.

June 20*th*. Three large in the 6th stage, 1 dark smoky-black; 1 greyish smoky-black, and 1 intermediate, greenish-brown. One small one dead, 1 missing.

June 26th. One had pupated, and 1 was mature and removed. The 3rd larva was greyish smoky-black.

July 2nd. The last larva had become mature and was removed.

CONCLUSIONS.

The great power of a black environment is well shown, in the production of 2 dark larvæ and 1 intermediate. At the same time the dark larvæ were not quite the characteristic forms produced by black-barked twigs.

C. *A. betularia.*

May 25th. Ten of the 20 *betularia* larvæ transferred from green to black for the 3rd stage, and re-transferred to green at the end of it when they were changing the 3rd skin and 14·0 mm. long.

May 29th. All in 4th stage and all dark.

June 2nd. Four in 5th stage, 5 changing 4th skin, 1 not quite mature in 4th stage. All dark brown.

June 5th. Four changing 5th skin and 33·0 mm. long; 2 nearly mature in 5th stage; all lightish brown overspread with a greyish cloud. Three small in the 5th stage, 2 of them as above and 1 dark brown. One in 4th stage and very black.

June 14th. Six nearly mature in the 6th stage and all very dark smoky-black with a pair of distinct grey patches on the dorsal surface of each segment. Three in the 5th stage, 2 as above and 1 lighter and really intermediate.

June 15th. Three dark larvæ had become mature and were removed.

June 18th. One dark larva mature and removed.

June 20th. Two larvæ large in the 6th stage, very dark smoky-black with the paired segmental light grey patches distinct.

June 26th. The 2 larvæ above described had become mature and were removed. Of the 3 remaining larvæ, 2 were large in the 6th stage, one bright green with brown dorsal line and a small brown patch on anterior part of each side of the segments, the other smaller and darker with more brown upon it, but still with a bright green ground-colour. The third larva in the 5th stage and chocolate-brown.

July 2nd. All 3 in 6th stage, but the smallest was now intermediate. In view of the considerable development of

brown markings the other 2 can only be considered as rather on the green side of intermediate.

July 12*th*. The smallest larva was still feeding and still intermediate. The other two had become mature and were removed. There was no further change.

CONCLUSIONS.

These results are deeply interesting. The 6 larvæ which first became mature were certainly influenced by the green environment of the three last stages, inasmuch as the final appearance was a dark smoky-black with a pair of distinct grey patches on each segment, instead of the well-known intense dead black which is the characteristic effect of the black-barked twigs of Turkish oak. At the same time, the remarkable susceptibility to this stimulus is seen in the pronounced darkness of these 6 larvæ after only a single stage (of 5 days' duration) had been passed among black twigs. It is interesting to note that the 3 intermediate larvæ grew more slowly after May 25th, and thus passed a relatively longer time in the green environment.

C[1]. *A. betularia.*

June 3*rd*. Two *betularia* larvæ at the beginning of the 5th stage re-transferred to green surroundings after they had been in black for the 3rd and 4th stages.

June 5*th*. A third larva, changing its 4th skin, was similarly re-transferred. It was of a light brown colour. Of the 2 former, 1 was nearly at the end of the 5th stage and dark brown, the other rather smaller and darkish brown overspread with grey.

June 7*th*. A fourth larva changing its 4th skin and a fifth at the beginning of the 5th stage were similarly re-transferred.

June 14*th*. Three larvæ in 6th stage, smoky-black with prominent light grey markings especially distinct in one of them. One in 5th stage and 1 changing 5th skin, both dark chocolate-brown with a little grey.

June 20*th*. Four large in the 6th stage, smoky-black overspread with grey. The black ground-colour resembles that of the larvæ still in black surroundings.

June 23*rd*. Two had become mature and were removed.

June 26*th*. Two mature and removed. The 5th was

now large in the 6th stage, a dark brownish-black rather than the dead black of the other 4 and those still on the black twigs.

July 12*th*. Mature and removed. No further change in appearance.

CONCLUSIONS.

In this case the grey which overspread the black ground-colour of 4 larvæ must be regarded as an effect of the green environment during the 2 last stages. The 5th larva took longer to develop, and there was a slight departure from the characteristic dead black of the other four.

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Results of Experiments in 1893 upon the Colour-relation between the larvæ of Odontopera bidentata and their environment.

Explanation of Plate XVI.

Results of Experiments in 1893 upon the colour-relation between the larvæ of *Odontopera bidentata* and their environment.

All the figures are of the natural size.

Fig. 1. Nearly mature larva of *O. bidentata* showing the effect of an environment of black-barked twigs (*Quercus cerris*). This typical example of the results of Experiment I was painted by Mr. P. J. Bayzand on July 31st, 1893. All the larvæ figured on this plate were fed upon the leaves of *Populus nigra*, but they nearly always rested by day on the twigs or pieces of bark made use of in the experiments here illustrated. The larva represented in this figure is not in its normal diurnal resting position, having been disturbed; and the same is more or less the case with Figs. 3, 5, 7 and 9.

2. Nearly mature larva showing the effect of an environment of weathered pale grey barkless twigs. This typical example of the final results of Experiment VII was painted on July 28th. A little earlier the larvæ had been rather paler and resembled more closely the majority of the twigs made use of.

3. Nearly mature larva showing the effect of an environment of dark purplish-brown, glossy twigs, probably of birch. This typical result of Experiment III was painted on July 30th.

4. Nearly mature larva showing the effect of an environment of white-spotted, purplish-brown twigs of birch. This typical result of Experiment IV was painted on July 30th. Although the details of the environment were not reproduced, the larva was distinctly less dark than that shown in Fig. 3.

5. Nearly mature larva showing the effect of an environment of green leaves and shoots. The food-plant (*Populus nigra*) was employed for this purpose, all dark-barked twigs being carefully excluded. A comparison of this figure with the others on the same plate indicates that the leaves of the food-plant produce no effect when they are combined with dark twigs or lichen-covered bark; while a reference to Experiments I to XV shows that the great majority of the larvæ rest by day upon these latter objects in preference to the leaves. This typical result of Experiment VIII was painted on July 31st.

FIG. 6. About half-grown larva showing the effect of an environment of bark covered with bluish-green lichen, probably *Physcia pulverulenta.* This typical result of Experiment XIII was painted on August 1st.

7. About half-grown larva showing the effect of the environment last described. This second typical example of the results of Experiment XIII was painted on August 3rd.

8. Nearly mature larva showing the effect of an environment of bark covered with orange lichen, perhaps *Physcia parietina*, probably combined with *P. pulverulenta.* This typical result of Experiment XIV was painted on August 4th.

9. Nearly mature larva showing the effect of the environment last described. This second typical example of the results of Experiment XIV was painted on August 5th.

10. Nearly mature larva showing the effect of an environment of lichen-covered sticks. The lichen was probably *Ramalina farinacea.* This typical result of Experiment XV was painted on August 10th.

11. Nearly mature larva showing the effect of the environment described in Fig. 6. This third typical example of the results of Experiment XIII was painted on August 31st.

Comparing the last six figures of larvæ together with the representation of the various forms of lichen-covered bark employed in the experiments, it is seen that there was no special resemblance to the characteristic features which distinguished one form of environment from the others. Thus the orange colour of the lichen did not produce any corresponding effect upon the larvæ shown in Figs. 8 and 9.

The whole results prove that *bidentata* is a larva with remarkable susceptibility to the colour of its environment. In this respect it is equal to the most sensitive of all larvæ hitherto tested—*Amphidasis betularia.* The latter is more susceptible to green leaves and shoots, becoming bright green when restricted to their influence. When exposed to lichen-covered bark, however, *bidentata* was shown, in Experiments XII to XV, to be far more sensitive.

EXPLANATION OF PLATE XVII.

Results of Experiments in 1893–4 upon the colour-relation between the larvæ of *Gastropacha quercifolia* and their environment.

All the figures are of the natural size, and all represent the normal resting position, except that the larvæ more frequently rest

with the head downwards than is shown in the plate. Perhaps the young larvæ under normal conditions invariably rest in this position.

Figs. 1—13 represent the larvæ in the autumn of 1893, just before the beginning of hybernation.

Figs. 14 and 15 represent the larvæ, nearly mature in the last stage, in May 1894.

FIG. 1. Larva of *Gastropacha quercifolia* just before hybernation, showing the effect of an environment of black-barked twigs (*Quercus cerris*). This typical example of the nine black larvæ, chequered with white, described on September 21st, 1893, was painted by Mr. Bayzand on September 25th. Although these larvæ had eaten very little, and had not grown appreciably by October 3rd, the white marks on six out of nine of them had become reduced almost to the condition represented in Fig. 3. The white patches on the larva shown in Fig. 1 had also become much duller and less conspicuous. The persistence of the process of colour-adjustment right up to the beginning of hybernation is very interesting, and contrasts remarkably with its entire cessation during and after hybernation. The difficulty with which the contour of the larvæ could be made out against the black bark is correctly rendered in Figs. 1—3.

2. Larva at the same period and exposed to the same environment as that shown in Fig. 1. The figure represents the darkest larva, without any trace of white markings, described on September 21st. The painting was made on September 23rd.

3. Larva at the same period and exposed to the same environment as that shown in Fig. 1. This typical example of five out of the six darkest larvæ, described on September 21st, was painted on September 26th.

4. Larva just before hybernation, showing the effect of an environment of lichen-covered sticks. The lichen was probably *Ramalina farinacea*. The figure represents one of the four lightest coloured larvæ produced in this environment and separated for painting on September 21st. The larva was painted on October 3rd. By October 16th, when the larvæ of series II were arranged for hybernation, many changes had taken place, but this larva remained among the lightest throughout.

5. Larva at the same period and exposed to the same environment as that shown in Fig. 4. The figure represents

one of the four lightest larvæ on October 6th when it was painted. It was not among the four lightest larvæ on September 21st, but changes took place after this date.

FIG. 6 Larva at the same period and exposed to the same environment as that shown in Fig. 4. The figure represents one of the four lightest larvæ separated for painting on September 21st, and the only one which remained of a greyish tint, the others becoming brownish. It was painted on October 2nd.

7. Larva at the same period and exposed to the same environment as that shown in Fig. 4. The figure represents one of the commonest types of appearance on September 21st, viz. the group of six dark white-marked larvæ. The drawing was made on October 10th.

8. Larva at the same period and exposed to the same environment as that shown in Fig. 4. Among the eight darkest larvæ of this series II on September 21st, was one in which the white markings possessed a bluish tinge. This was set aside for painting. But changes took place later on, and one of the other seven larvæ was found more nearly to represent the previous appearance of the separated larva. The former, which had become greyish, was therefore painted on October 9th.

9. Larva at the same period and exposed to the same environment as that shown in Fig. 4. The description of Fig. 4 applies in every respect except that the larva here represented was painted on October 7th.

10. Larva just before hybernation, showing the effect of an environment of reddish-brown stems of bramble. The larva represented was one of the two mentioned on October 16th, in which the light patches were well developed and of a brownish tint. It was painted on October 13th.

11. Larva at the same period and exposed to the same environment as that shown in Fig. 10. The larva represented was the lightest of the seven very uniform dark brown larvæ with lighter brown patches and small white marks mentioned on October 16th. These light patches, which are not very distinct in this figure and in Fig. 13, were generally present on the 2nd, 5th, and 8th abdominal segments. The larva was painted on September 30th.

12. Larva at the same period and exposed to the same environment as that shown in Fig. 10. The larva represented was the brown individual with the dorsal surface

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Effects of lichen, of black twigs, and of reddish brown sticks upon the larvæ of Gastropacha quercifolia (1893–4).

overspread with grey mentioned on October 16th. The greyish appearance does not come out in the figure, the effect being merely to render the brown of a paler tint. The larva was painted on October 17th.

FIG. 13. Larva at the same period and exposed to the same environments as that shown in Fig. 10. The description of Fig. 11 applies in every respect, except that the larva here represented was a specially dark example, and was painted on October 16th.

14. Larva, nearly mature in the last stage, showing the effect of an environment of black-barked twigs up to the beginning of hybernation. During and after hybernation the larva was placed (I, B) in an environment of lichen-covered sticks, but, as the figure indicates, it had ceased to be susceptible to such influences, and no effect was produced. Before hybernation it had been one of the five darkest larvæ. The painting was made on May 19th.

15. Larva at the same period and exposed to the same environments (I, B) both before and after hybernation as that shown in Fig. 14. Although conspicuous white patches appeared on this and other larvæ subsequent to hybernation, it is improbable that this effect was due to the lichen which formed the surroundings after the beginning of hybernation. The comparison of the whole of the larvæ indicates that they had then ceased to be susceptible to the colours of the environment. The larva was painted on May 22nd.

EXPLANATION OF PLATE XVIII.

Results of Experiments in 1893–4 upon the colour-relation between the larvæ of *Gastropacha quercifolia* and their environment.

All the figures are of the natural size, and all represent the natural resting position.

All the figures represent the larvæ in the last stage, and all but one nearly mature, in May 1894.

FIG. 1. Larva of *Gastropacha quercifolia*, nearly mature in the last stage, showing the effect of an environment of lichen-covered sticks up to the beginning of hybernation. The lichen employed was probably *Ramalina farinacea*. During and after hybernation the larva was placed in an environment of black-barked twigs (II. G) which, it is

obvious, produced no effect whatever. The appearance of this same larva just before hybernation is represented in Plate XVII, fig. 4 or 9. The painting of the nearly mature larva was made on May 14th.

FIG. 2. Larva, small but probably in the last stage, exposed to the same environments (II, G) both before and after hybernation, as that represented in fig. 1. Here too it is clear that the black-barked twigs which surrounded the larva during winter and spring produced absolutely no effect. The appearance of the same larva just before hybernation is represented on Plate XVII, Fig. 6. The painting of the more mature larva was made on May 28th.

3. Larva, nearly mature in the last stage, showing the effect of lichen-covered sticks throughout (II, F). The lichen was probably *Ramalina farinacea*. The appearance of this same larva just before hybernation is represented in Plate XVII, fig. 4 or 9. The painting of the nearly mature larva was made on May 25th.

4. Larva at the same period and exposed to the same environments both before and after hybernation as that represented in Fig. 1. The larva here represented (from II. E) was the darkest of all the mature larvæ which had been exposed to an environment of lichen before hybernation (series II). There is no reason to suppose that the black twigs produced any effect in winter and spring. The larva was one of the seven darkest in series II before hybernation. The painting was made on May 17th.

5. Larva, nearly mature in the last stage, showing the effect of reddish-brown stems of bramble throughout (III, K). The specimen represented was one of the four more spotted or lightest larvæ before hybernation, and the same relationship towards the other divisions of this series (III) was maintained during and after hybernation. The painting was finished on May 11th.

6. Larva, nearly mature in the last stage, showing the effect reddish-brown stems of bramble before hybernation. During and after hybernation the larva was placed in an environment of black-barked twigs (III, J). It had been one of the uniform brown larvæ before the winter, and there is no reason for the belief that the black twigs introduced later produced any effect. The painting was finished on May 11th.

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Effects of lichen and of reddish brown sticks upon the larvæ of Gastropacha quercifolia (1893–4).

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The Influence of Darwin upon Entomology.

By Professor EDWARD B. POULTON, M.A., F.R.S., F.Z.S., &c.

The published letters of Charles Darwin show that he had a very poor opinion of systematic work in zoology. His labour in preparing the *Monograph on the Cirripedia* showed him that a large proportion of the descriptions of species are slovenly and superficial, and he thought that this bad work was encouraged by the custom of appending the describer's name to the species. Thus he wrote to Sir Joseph Hooker (then Dr. Hooker), October 6th, 1848 :—" I have lately been trying to get up an agitation . . . . against the practice of Naturalists appending for perpetuity the name of the *first* describer to species. I look on this as a direct premium to hasty work, to *naming* instead of *describing*. . . . Botany, I fancy, has not suffered so much as zoology from mere *naming*; the characters, fortunately, are more obscure. . . . Why should naturalists append their own names to new species when Mineralogists and Chemists do not do so to new substances?" (*Life and Letters*, London, 1887, vol. i., pp. 364, 365.) A little later he carried on a correspondence with Hugh Strickland on the same subject. I quote a large part of his concluding letter. He writes on February 4th, 1849, "of the evil done by the 'mihi' attached to specific names; I can see most clearly the *excessive* evil it has caused; in mineralogy I have myself found there is no rage merely to name; a person does not take up the subject without he intends to work it out, as he knows that his *only* claim to merit rests on his work being ably done, and has no relation whatever to *naming*. . . . I think a very wrong spirit runs through all Natural History, as if some merit was due to a man for merely naming and defining a species; I think scarcely any, or none is due; if he works out *minutely* and anatomically any one species, or systematically a whole group, credit is due, but I must think the mere defining a species is nothing, and that no *injustice* is done him if it be over-looked, though a great inconvenience to Natural History is thus caused. I do not think more credit is due to a man for defining a species than to a carpenter for making a box. But I am foolish and rabid against species-mongers, or, rather, against their vanity; it is useful and necessary work which must be done; but they act as if they had actually made the species, and it was their own property" (*loc. cit.*, i., 370, 371). Again writing to Sir Joseph Hooker, on April 9th, 1849, he speaks of "the miserable and degrading passion of mere species-naming" (*loc. cit.*, i., 376). Although these strong opinions and expressions were roused in Darwin by the contemplation of bad systematic work in the Crustacea, the future student of the Insecta will find his task much lightened if they are considered to have a general bearing. Systematic labour is certainly "useful and necessary work which must be done," and there are reasons of expediency why the authorship of a name must be readily available (as Darwin himself felt compelled to admit). But if this "necessary" entomological work is not to lose much of its usefulness due regard must be paid to the warning conveyed in these early letters of our great English naturalist.

A few years later Darwin had done with his systematic monograph, and soon became entirely absorbed in the work which was to culminate in 1859 in the *Origin of Species*. These enquiries led him to believe that too exclusive attention to systematic work injures the reasoning faculties and the powers of generalising. Thus, he wrote to Sir Joseph Hooker, on September 25th, 1853, shortly before the appearance of the last *Cirripede* volumes: "How few generalisers there are among systematists; I really suspect there is something absolutely opposed to each other and hostile in the two frames of mind required for systematising and reasoning on large collections of facts" (*loc. cit.*, ii., 39, 40). Again, he wrote to A. R. Wallace, on December 22nd, 1857: "I am a firm believer that without speculation there is no good and original observation. . . . So few naturalists care for anything beyond the mere description of species" (*loc. cit.*, ii., 108). In a letter to Sir Joseph Hooker on November 21st, 1859, he emphasises the value of generalisation: "It is an old and firm conviction of mine that the naturalists who accumulate facts and make partial generalisations are the *real* benefactors of science. Those who merely accumulate facts I cannot very much respect" (*loc. cit.*, ii., 225). The same ideas are conveyed in a letter to H. W. Bates on December 3rd, 1861, referring to his paper on "Mimicry" in the *Trans. Linn. Soc.*: "I can understand that your reception at the British Museum would damp you; they are a very good set of men, but not the sort to appreciate your work. In fact, I have long thought that *too much* systematic work [and] description somehow blunts the faculties. The general public appreciates a good dose of reasoning, or generalisation, with new and curious remarks on habits, final causes, &c., far more than do the regular naturalists" (*loc. cit.*, ii., 379). He wrote again on November 20th, 1862, after reading the paper on "Mimicry": "Your paper is too good to be largely appreciated by the mob of naturalists without souls, but rely on it that it will have *lasting* value, and I cordially congratulate you on your first great work" (*loc. cit.*, ii., 393). Although the earlier reflections on systematic work came out of his study of the *Cirripedes*, the later were at any rate partially due to his experience of the students of insects. He seems, indeed, to have a somewhat poor opinion of entomological work, perhaps due to his experience with his own collections made on the "Beagle." At any rate, he wrote to Sir Joseph Hooker on September 2nd, 1860: ". . . . If you get to the top of Lebanon . . . . you ought to collect any beetles under stones there; but the Entomologists are such slow coaches. I dare say no result could be made out of them. [They] have never worked the Alpines of Britain" (*loc. cit.*, ii., 337). "[They]" in the last sentence is substituted for words of mock abuse, with no doubt a basis of truth intended to be expressed beneath the jest. Darwin evidently considered that the entomologists, as a whole, would be among the most uncompromising opponents of his views on evolution and natural selection. Thus he wrote to Sir Charles Lyell on March 17th, 1863, arguing that evolution would ultimately prevail: "But this result, I begin to see, will take two or three lifetimes. The entomologists are enough to keep the subject back for half a century" (*loc. cit.*, iii., 17). Such remarks in letters are, of course, not intended to be criticised as deliberate expressions of mature opinion, and there can be little doubt that in this case much

too despondent an attitude is assumed. A study of the *Transactions of the Entomological Society of London* from 1858 onwards will reveal numerous papers by well-known adherents of the new views, such as H. W. Bates, A. R. Wallace, and Sir J. Lubbock. One paper of H. W. Bates on South American butterflies is of peculiar interest. It was written as a letter to Adam White, from Ega, on the Upper Amazon, on May 20th, 1857, over a year before the Darwin-Wallace paper on natural selection was read before the Linnean Society on July 1st, 1858. Mr. Bates' letter is published as the first paper in vol. v of series ii (1858-1861) of the *Transactions*. Speaking of the *Heliconiidae*, he says: "This family I look upon as mostly a modern creation, the species unfixed, very susceptible of change, in conjunction with the least modification of local circumstance; but these theoretical notions I suppose you do not care about." This must be one of the first, if not the very first expression of opinion in favour of evolution published by a London scientific society. Not only did the Entomological Society publish a large number of papers by these great pioneers, but again and again they filled the most important offices. Thus, although Bates was a corresponding member of the Society when he wrote the paper from which I have quoted, he was on the Council in 1864, 1866, 1867, 1872, 1877, was a Vice-President in 1870, 1873, 1876, 1879, 1880, and President in 1868, 1869, and 1878. Wallace was a member of Council in 1866, 1872, Vice-President in 1864, 1869, and President in 1870, 1871. Lubbock was a Vice-President in 1862, 1868, and 1881, and President in 1866, 1867, 1879, 1880. The majority of the senior members of the Society were undoubtedly opposed to the new views, but there was evidently no attempt to boycott those who were known as strong and convinced supporters of them.

Although Darwin had written in such depressing terms of the entomologists in 1863, only four years later he went to the opposite extreme in a letter to Professor Haeckel. Writing on May 21st, 1867, he said: "No body of men were at first so much opposed to my views as the members of the London Entomological Society, but now I am assured that, with the exception of two or three old men, all the members concur with me to a certain extent" (*loc. cit.*, iii., 69). The words "to a certain extent" are, of course, elastic, but, stretching them to the utmost, it must be conceded that this last letter is as optimistic as the former is pessimistic. The members of the Society were fair, and gave a hearing and an important position to an opponent; but he still remained an opponent. A convinced evolutionist did not feel himself in the congenial society of those who agreed with him in principle even if they differed in detail in 1867, nor, for that matter, in 1877. By 1887 an immense improvement had been effected, but Darwin's words could only be used of this date by those of a very sanguine temperament. However, the changes were well under weigh which were to make them entirely appropriate before the end of the next decade.

It is interesting to remember that the three epoch-making papers on mimicry by H. W. Bates, A. R. Wallace, and R. Trimen appeared respectively in 1862, 1866, and 1870, in the *Transactions of the Linnean Society* and not in those of the Entomological Society. This fact is no doubt partly due to the special suitability of the quarto form

of publication for these monographs and partly to the appropriate channel afforded by the Society, which first gave natural selection to the world in 1858, but it probably also indicates that the Entomological Society was not at that date exactly a congenial home for the free discussion and subsequent publication of such hypotheses. I well remember, about the year 1875, when I was an undergraduate, the gravity and, indeed, almost consternation with which Professor Westwood, when he enquired what I was studying, received my reply that I was reading the *Origin of Species*. He told me that it was a book which so young a man ought not to read except under the most careful guidance, and he seemed to think that there was some failure of duty or, at any rate, some want of caution in my being allowed to have the book all!

The great change in relation to these opinions which has gradually come over the Society and over British entomology generally is especially due to the energy, zeal, and ability of a single man. Darwin described Huxley as his "general agent"; in relation to entomology his agent was Raphael Meldola. He became a member of the Society in 1872, was elected on the Council in 1874 and 1875, becoming Secretary in 1876, an office which he retained till 1880. In 1884 he was a Vice-President, and on the Council in 1885. I do not refer to the offices he has held at a later date, because the struggle was then practically over. Throughout the whole of the period included between the above-mentioned dates, and especially during his tenure of the office of Secretary, he was unremitting in his efforts to interest the Society in evolution and natural selection as applied to the problems of insect life and structure. Darwin received many letters from Dr. Fritz Müller containing most interesting and suggestive observations. These were translated by Meldola and brought before the Society. In 1879 he brought before the Society, and published in the *Proceedings* (p. xx), a translation of Fritz Müller's paper, which had only just appeared in *Kosmos* (May, 1879, p. 100), making known his suggestion as to the reason for resemblances between protected species in the hypothesis which has since been known as Müllerian mimicry, or the hypothesis of common warning or synaposematic colours. This new suggestion he sustained even against H. W. Bates, who had himself suggested the older theory of mimicry, and later against W. L. Distant. In 1882 (*Ann. Mag. Nat. Hist.*, Dec.) he extended the suggestion to explain broader resemblances between the species of distasteful groups generally. The outcome of his energy has been that the Müllerian suggestion has produced far more effect here than in its native country, and that the natural centre for controversy for the discussion of such questions shifted from the Linnean to the Entomological Society. In 1882 Meldola published a translation of Weismann's *Studies in the Theory of Descent*, which had also been brought before his notice by Darwin, who, indeed, suggested the English edition. This work has strong personal interest to the present writer inasmuch as it was the cause of his gradual absorption in the problems of insect bionomics, and abandonment of the histological researches on the lower Mammalia upon which he had up to that time been engaged.

When we enquire as to the effect produced by these changes upon the direction and scope of entomological enquiry, the answer is both interesting and in many ways curious and unexpected. The result has been a return of the spirit which animated the older enquirers

before zoological science became locked fast in the paralysing grip of pure systematics. When we read Réaumur or De Geer, the whole point of view is entirely familiar. In describing some of the wonderful means of defence of the larva of *Cerura vinula*, De Geer merely speaks of the "caterpillar of the sallow." Our sympathies are with Lyonnet, who carefully describes the anatomy of "the caterpillar which eats the wood of the willow." These men were *naturalists*, interested in the infinitely difficult and infinitely numerous problems presented by living nature. We find the same spirit in the early Darwinian writers; it shines forth clearly not only in the bionomic monographs, but also illuminates the systematic papers of Bates, Wallace, and Trimen, and now it has become the common heritage of entomology. Systematic work is as "useful and necessary" as ever, indeed even more so, for it becomes a necessity not only as an end in itself, but as the foundation for endless other inquiries. This, then, is the great gain which British entomology owes to Darwin's influence, received first through the early Darwinian writers, and then through the energy and ability of Raphael Meldola—that we are inspired to become naturalists and observers, rather than collectors, that we describe and distinguish species as the means for knowing more about them as living animals, and that endless new lines of observation are opened up to us from the high vantage ground which we occupy as firm believers in the doctrine of evolution and the process of natural selection as its motive cause.

[*From the* Proceedings of the Zoological Society of London, November 20, 1900.]

Revision of the Rhynchota belonging to the Family *Pentatomidæ* in the Hope Collection at Oxford. By W. L. Distant.

(Plates LII. & LIII.)

In the years 1837 and 1842 there were published at Oxford Parts I. and II. of 'A Catalogue of Hemiptera in the Collection of the Rev. F. W. Hope,' which still form part of the well-known "Hope Collection" in the Oxford Museum. Part I. bears no name of author, and the descriptions therein have very often been ascribed to Hope, as his name is appended to the nomenclature. Part II. is stated to have been written by the late Prof. Westwood, and there is no doubt that he was the author of both, and that conclusion is now generally followed by entomologists.

The publication consists of short Latin descriptions of a considerable number of species considered as then undescribed; but of these many now rank only as synonyms and mostly require generic revision—a result which causes little surprise when the

fragmentary knowledge of the Order in those days is considered, with the obscurity that then enshrouded the Fabrician species, which Westwood seems to have almost ignored. Much of this synonymy has been elucidated, especially by the late Dr. C. Stål, who in 1862 visited this country, examined the collection and made notes thereon, which were published in the Öfv. Vet.-Akad. Förh. 1862, p. 501. These were again given, sometimes in a revised form, in his subsequent 'Enumeratio Hemipterorum.' Like all Stål's work, this casual examination produced reliable correction, but much was still left in an obscure condition, and our catalogues contain many doubtful references to a number of Westwood's species described from this collection.

I have to thank Prof. Poulton, who has succeeded Prof. Westwood at Oxford, for placing the whole collection in my hands for comparison and revision. I have carefully compared all the types with those contained in the British Museum and my own collection, with the result of finding that though many of Westwood's species must rank as synonyms, he has on the other hand priority in many cases over the descriptions of more recent workers, who have failed to recognize his species by their short descriptions and unrevised generic position. It is probable that Continental describers may also be compelled to withdraw some of their own descriptions for a similar reason, and the figures with which the Society has allowed me to illustrate this communication may facilitate that result.

Some few species are in such indifferent condition as to render generic identification impossible—at least with certitude; but in most cases these are figured, and thus eventually, when better specimens reach the hands of workers, they can be recognized and then generically disposed.

Subfam. Discocephalinæ.

Dinocoris unicolor.

Dinidor unicolor Westw. in Hope Cat. i. p. 25 (1837).
Antileuchus piceus Dall. (part.) List Hem. i. p. 165. n. 6 (1851).
Dinocoris unicolor Stål, En. Hem. ii. p. 9. n. 16 (1872).
Dinocoris piceus Dist. (part.) Biol. Centr.-Am., Rhynch. i. p. 46. n. 2 (1880).

In the Biol. Centr.-Amer. I had followed Dallas in placing the *D. unicolor* Westw. as a synonym of *D. piceus* Pal. Beauv. On examination I find the two species are quite distinct, that of Westwood having a greater width of abdomen and the upper surface distinctly rugose.

Dinocoris tessellatus.

Dinidor tesselatus Westw. in Hope Cat. i. p. 24 (1837).
Dinocoris tessellatus Stål, En. Hem. ii. p. 9. n. 14 (1872).

A species closely allied to the *D. amplus* Walk., but having the second and third joints of the antennæ wholly black.

Subfam. PENTATOMINÆ.

SPUDÆUS PARVULUS. (Plate LII. fig. 1.)

Halys parvula Westw. in Hope Cat. i. p. 22 (1837).

The species identified with this by Dallas (List Hem. i. p. 169, 1851) is altogether different, and must not be treated as the same, as has been enumerated by Stål, and catalogued by Lethierry and Severin.

DALPADA CLAVATA.

Cimex clavatus Fabr. Ent. Syst. Suppl. p. 532 (1798).
Halys latipes Westw. in Hope Cat. i. p. 23 (1837).
Halys concinna Westw. loc. cit.

NEVISANUS ALTERNANS.

Halys alternans Westw. in Hope Cat. i. p. 22 (1837).
Nevisanus orientalis Dist. Ann. & Mag. Nat. Hist. ser. 6, vol. xi. p. 391 (1893).

ORTHOSCHIZOPS ASSIMILIS. (Plate LII. fig. 2.)

Halys assimilis Westw. in Hope Cat. i. p. 21 (1837).
Orthoschizops assimilis Stål, En. Hem. v. p. 49. n. 8 (1876).

ORTHOSCHIZOPS ? RUGOSUS. (Plate LII. fig. 3.)

Atelocerus rugosus Westw. in Hope Cat. i. p. 21 (1837).

The type and only specimen which I have seen is without the abdomen, and is consequently unable to be strictly identified in a generic sense. It seems, however, to belong to the genus *Orthoschizops*.

(?) HALYS RUFESCENS Westw. in Hope Cat. i. p. 24 (1837).

This species is recorded by Stål (En. Hem. v. p. 42, 1876) as belonging to the genus *Pœcilometis*. It is not, however, contained in the type collection forwarded to me from Oxford.

(?) HALYS DENTIPES Westw. in Hope Cat. i. p. 24 (1837).

I have the following note from Oxford relating to this species—" *dentipes* is missing, space empty, specimen not to be found."

KALULA, gen. nov.

Body elongate. Head long, about two-thirds the length of the pronotum, the lateral margins sinuate and slightly widened, rounded, and moderately laminate at the apices of the lateral lobes, which are a little longer than the central lobe and cleft centrally; antennæ moderately short, first joint not nearly reaching apex of head, second joint considerably passing it, fourth and fifth joints distinctly thickened; ocelli much nearer eyes than to each other; rostrum reaching the posterior coxæ. Pronotum distinctly depressed from between the pronotal angles, which

are obtusely prominent at about the centre of the lateral margins, from which the margins are concavely sinuate to apex. Scutellum about half the length of abdomen. Abdomen unarmed.

I have placed this genus near *Ocrophara* Stål, from which, apart from other differences, it may be distinguished by the shape and structure of the head.

KALULA VARICORNIS. (Plate LII. fig. 4.)

Œlia varicornis Westw. in Hope Cat. i. p. 33 (1837).

Hab. Gambia.

DICTYOTUS SEMIMARGINATUS.

Pentatoma semimarginata Westw. in Hope Cat. i. p. 42 (1837).

Westwood gave no locality for his species, but the British Museum possesses specimens from Baudin Island, West Australia.

Antennæ with the first and second joints ochraceous, third, fourth, and fifth joints piceous, apices of third and fourth joints ochraceous.

DICTYOTUS CÆNOSUS.

Pentatoma cœnosa Westw. in Hope Cat. i. p. 42 (1837).
Pentatoma vilis Walk. Cat. Het. ii. p. 309. n. 147 (1867).
Dictyotus vilis Dist. Ann. & Mag. Nat. Hist. ser. 7, vol. iv. p. 434 (1899).

I have previously given the full synonymy of this species, but now, from an examination of the Hope Collection, am compelled to remove it one stage further back.

DICTYOTUS PALLIPES. (Plate LII. fig. 9.)

Pentatoma pallipes Westw. in Hope Cat. i. p. 41 (1837).

In size and general appearance allied to *D. roei* Westw., but having the head more elongate and not prominently cleft at the apex, the central lobe being longer.

Westwood's type is unlocalized, and I have not seen another specimen.

DICTYOTUS ROEI.

Pentatoma roei Westw. in Hope Cat. i. p. 42 (1837).
Dictyotus affinis Dall. List Hem. i. p. 141. n. 4 (1851).

This is not the species identified by Dallas as *roei* Westw. (List Hem. i. p. 140), which is an ally of *D. tasmanicus* Dall., and is the *D. æqualis* Walk.

NIPHE SUBFERRUGINEA.

Pentatoma ferruginea Westw. in Hope Cat. i. p. 35 (1837).
Pentatoma cephalus Dall. List Hem. i. p. 245. n. 32 (1851).
Pentatoma lateralis Walk. Cat. Het. ii. p. 301 (1867).
Niphe cephalus Dist. Ann. & Mag. Nat. Hist. ser. 7, vol. iv. p. 435 (1899).

Tropicorypha deplanata.

Pentatoma deplanata Westw. in Hope Cat. i. p. 35 (1837).
Agonoscelis rufescens Walk. Cat. Het. iii. p. 546 (1868).
Tropicorypha rufescens Dist. Ann. & Mag. Nat. Hist. ser. 7, vol. iv. p. 435 (1899).

Palomena prasina.

Cimex prasinus Linn. Faun. Suec. p. 241. n. 931 (1761).
Pentatoma confusa Westw. (MS.) in Hope Cat. i. p. 9. n. 65 (1837).

This species stands, as Westwood pointed out, under the name of *juniperinus* in the Banksian Collection. Westwood apparently substituted his name *confusa*, but did not describe the species.

Palomena viridissima.

Cimex viridissima Poda, Ins. Mus. Gr. p. 56. n. 10 (1761).
Pentatoma rotundicollis Westw. (MS.) in Hope Cat. i. p. 9. n. 66 (1837).

This appears to be a name substituted by Westwood for "*prasinus* Wolff nec Linn.," and with no published description.

Palomena unicolor. (Plate LII. fig. 5.)

Pentatoma unicolor Westw. in Hope Cat. i. p. 41 (1837).

A species allied to *P. spinosa* Dist. and *P. angulosa* Motsch.

Pentatoma senilis.

Pentatoma senilis Say, New Harm. Ind., Dec. 1831; Compl. Writ. i. p. 316. n. 8 (1859); Leth. & Sev. Cat. Gén. Hém. i. p. 120 (1893).
Lioderma (*Rhytidolomia*) *senilis* Stål, En. Hem. p. 33. n. 2 (1872).
Pentatoma ovalis (*oblonga*) Westw. in Hope Cat. i. p. 39 (1837).
Pentatoma grisea Dall. List Hem. i. p. 246. n. 33 (1851).

This is not the *P. oblonga* Westw. loc. cit. p. 37, as stated by Stål (En. Hem. ii. p. 33) and repeated by Lethierry and Severin (Cat. p. 120), which is a Javan species, and a synonym of *Nezara viridula* Linn.

Mormidea scutellata. (Plate LII. fig. 7.)

Pentatoma scutellata Westw. in Hope Cat. i. p. 37 (1837).

Euschistus servus.

Pentatoma serva Say, New Harm. Ind., Dec. 1831; Compl. Writ. vol. i. p. 314 (1859).
Pentatoma spilota Westw. in Hope Cat. i. p. 42 (1837).

Westwood's habitat is "Brasilia ?," but it is doubtless a North American specimen which forms the type of his *P. spilota*.

EUSCHISTUS TRISTIGMUS.

Pentatoma tristigma Say, New Harm. Ind., Dec. 1831; Compl. Writ. i. p. 314 (1859).
Pentatoma inconspecta Westw. in Hope Cat. i. p. 42 (1837).

ILERDA PALLESCENS. (Plate LII. fig. 10.)

Pentatoma pallescens Westw. in Hope Cat. i. p. 41 (1837).

A species allied in structnre to *I. sudana* Dist.

CARBULA OBSCURA.

Pentatoma obscura Westw. in Hope Cat. i. p. 35 (1837).

CARBULA INSOCIA.

Eysarcoris insocius Walk. Cat. Het. iii. p. 556 (1868).
Pentatoma bimaculata Westw. MS.

In the Hope Cat. i. p. 35, under the MS. name *Pent. bimaculata* Westwood unites "*Species delenda, varietas præcedentis*," referring to his *Carbula* (*Pent.*) *obscura*. The two species are, however, quite distinct and easily distinguished by the shape and structure of the pronotal angles.

CARBULA DIFFICILIS.

Pentatoma difficilis Westw. in Hope Cat. i. p. 35 (1837).

A species resembling largely the *C. insocia* Walk.

CARBULA MELACANTHA.

Cimex melacanthus Fabr. Ent. Syst. iv. p. 103 (1794).
Pentatoma hostilis Westw. in Hope Cat. i. p. 40 (1837).

CARBULA INDICA.

Pentatoma indica Westw. in Hope Cat. i. p. 42 (1837).
Carbula fusca Dist. Trans. Ent. Soc. Lond. 1887, p. 346.

THYANTA ANTIGUENSIS.

Pentatoma antiguensis Westw. in Hope Cat. i. p. 36 (1837).
Pentatoma tæniola Dall. List Hem. i. p. 250 (1851).

THYANTA VITREA.

Pentatoma vitrea Westw. in Hope Cat. i. p. 36 (1837).

Type in bad condition, without abdomen.

MURGANTIA VARICOLOR.

Pentatoma varicolor Westw. in Hope Cat. i. p. 37 (1837).
Strachia munda Dall. List Hem. i. p. 264. n. 19 (1851).
Murgantia tessellata? Leth. & Sev. Cat. Gén. Hém. t. i. p. 156 (1893).

NEZARA CHLOROCEPHALA.

Pentatoma chlorocephala Westw. in Hope Cat. i. p. 38 (1837).

Lethierry and Severin (Cat. Gén. Hém. t. i. p. 167) have

placed this species as a synonym of *N. viridula* Linn. From that species *N. chlorocephala* differs by its elongate form, and particularly by its more elongate and narrower head.

Westwood localized it as "Brasilia?" The British Museum possesses specimens from Nyasaland collected by Mr. A. Whyte.

Nezara chloris.

Pentatoma chloris Westw. in Hope Cat. i. p. 38 (1837).
Pentatoma mentiens Walk. Cat. Het. ii. p. 296. n. 92 (1867).

Stål (En. Hem. ii. p. 41, 1872) places this species as a synonym of *Nezara viridula* Linn. In this case, however, he has fallen into error. *N. chloris* is a smaller, more elongate, narrower, and much more convex species; the head is large and broad.

I possess specimens both from Congo and Nyasaland.

Nezara capicola.

Pentatoma capicola Westw. in Hope Cat. i. p. 39 (1837).
Pentatoma lata Westw. loc. cit.
Pentatoma frontalis Westw. loc. cit. p. 37.
Rhaphigaster capicola Dall. List Hem. i. p. 276. n. 5 (1851).
Nezara capicola Stål, Hem. Afr. i. p. 195. n. 3 (1864).
Pentatoma africana Westw. in Hope Cat. i. p. 39 (1837).

P. frontalis and *P. africana* are colour varieties. In the strict usage of the laws of priority, *frontalis* is the earliest name; but as this is clearly a variety or "sport," I do not disturb the arrangement of Dallas and Stål.

Nezara viridula.

Cimex viridulus Linn. Syst. Nat. ed. 10, i. p. 444. n. 28 (1758).
Pentatoma oblonga Westw. in Hope Cat. i. p. 37 (1837).
Pentatoma unicolor Westw. loc. cit. p. 38.
Pentatoma berylina Westw. loc. cit.
Pentatoma subsericea Westw. loc. cit.
Pentatoma leii Westw. loc. cit.
Pentatoma tripunctifera Westw. loc. cit.
Pentatoma proxima Westw. loc. cit.
Pentatoma chinensis Westw. loc. cit.
Rhaphigaster subsericeus Dall. List Hem. i. p. 275. n. 3 (1851).
Nezara viridula Stål (part.), En. Hem. ii. p. 41. n. 6 (1872).

Ætius, gen. nov.

Body moderately short, broad, and convex. Head long, almost as long as the pronotum, lateral margins strongly sinuate, lateral lobes a little longer than the central lobe and cleft at apices; antennæ four-jointed, basal joint not quite reaching apex of head, second joint very long, third and fourth joints subequal in length; ocelli placed somewhat near the eyes; rostrum reaching the posterior coxæ, second joint longest. Pronotum broad, the lateral angles produced in long robust spines directed forward

and somewhat upward; anterior lateral margins coarsely dentate, a somewhat larger and lobate tooth at anterior angle. Scutellum broad, sinuate about centre. Connexivum prominent; abdomen beneath with a broad central sulcation, which does not extend to apex.

ÆTIUS VARIEGATUS. (Plate LII. fig. 8.)

Atelocerus? variegatus Westw. in Hope Cat. i. p. 21 (1837).
Hab. Australia: Swan River.

PLAUTIA FIMBRIATA.

Cimex fimbriatus Fabr. Mant. ii. p. 295 (1787).
Pentatoma fimbriata Westw. in Hope Cat. i. p. 32 (1837).

PLAUTIA VIRIDICOLLIS.

Pentatoma viridicollis Westw. in Hope Cat. i. p. 35 (1837).
Plautia viridicollis Leth. & Sev. Cat. Gén. Hém. i. p. 169 (1893).
Pentatoma inconspicua Dall. List Hem. i. p. 250. n. 42 (1851).

CRESPHONTES MONSONI. (Plate LII. fig. 6.)

Raphigaster monsoni Westw. in Hope Cat. i. p. 31 (1837).
Cresphontes nigro-maculatus Haglund, Stett. ent. Zeit. xxix. p. 157 (1868).

Westwood recorded a wrong locality ("Caput Bonæ Spei") for this species. I have compared the types of both Westwood and Haglund.

ANTESTIA CRUCIATA.

Cimex cruciatus Fabr. Syst. Ent. p. 714 (1775).
Pentatoma pantherina Westw. in Hope Cat. i. p. 34 (1837).

Westwood undoubtedly was led astray by the wrong habitat "*Georgia Americæ*" in redescribing this well-known Oriental species.

ACTUARIUS, gen. nov.

Body oblong. Head with the lateral lobes considerably longer than the central lobes, and very distinctly cleft at their apices, which are obliquely rounded, their lateral margins moderately sinuate; ocelli situate between the eyes and nearer to them than to each other. Antennæ with the second joint a little shorter than either third or fourth, which are subequal in length; rostrum about reaching the posterior coxæ, second joint longest, third slightly shorter than the fourth. Pronotum long, moderately convex, the lateral margins sinuate, the posterior angles rounded and subprominent, the anterior angles shortly dentate. Scutellum about half the length of the abdomen, slightly gibbous at base, narrowed towards apex. Corium distinctly moderately widened at about one-third from base; membrane with longitudinal veins.

Abdomen probably spined at base, but mutilated there by pin in type and only specimen.

Allied to *Menida* Motsch.

Actuarius albonotatus. (Plate LII. fig. 11.)

Pentatoma albonotata Westw. in Hope Cat. i. p. 37 (1837).

Hab. Gambia.

Menida histrio.

Cimex histrio Fabr. Mant. ii. p. 296. n. 176 (1787).
Pentatoma bengalensis Westw. in Hope Cat. i. p. 36 (1837).

Ocirrhoë roei. (Plate LII. fig. 12.)

Rhynchocoris roei Westw. in Hope Cat. i. p. 30 (1837); Leth. & Sev. Cat. Gén. Hém. i. p. 181 (1893).

The species identified by Dallas (List Hem. i. p. 297. n. 4, 1851) is not conspecific.

Ocirrhoë ? virescens. (Plate LIII. fig. 7.)

Raphigaster virescens Westw. in Hope Cat. i. p. 31 (1837).

The type and only specimen is in a very mutilated condition, wanting the abdomen, but the species apparently belongs to the genus *Ocirrhoë*.

Avicenna, gen. nov.

Head deflected, moderately broad, lobes of equal length, apex rounded, lateral margins moderately sinuate at about centre. Antennæ with the second and third joints subequal in length, or second slightly shorter than the third. Pronotum strongly deflected anteriorly from between the area of the lateral angles; lateral margins moderately concavely sinuate, punctate before anterior margin, posterior margin strongly concave at base of scutellum; posterior angles subprominent, lateral angles produced in long acute spines. Scutellum broad, distinctly narrowed a little before apex. Rostrum with the second and third joints about subequal in length. Sternal process extending beyond base of head. Spines at apices of sixth abdominal segment and anus strongly developed.

This genus agrees with *Morna* in the concave posterior margin of the pronotum, but differs in not having the posterior pronotal angles acutely produced. It is allied to *Vitellus* by the shape and production of the sternal process, but differs by the less triangular and elongate head, the longer and non-triangular scutellum, &c.

Avicenna inquinata. (Plate LIII. fig. 1.)

Rhynchocoris inquinata Westw. in Hope Cat. i. p. 29 (1837).
Cuspicona inquinata Walk. Cat. Het. ii. p. 387. n. 29 (1867).
Vitellus inquinatus Leth. & Sev. Cat. Gén. Hém. p. 182 (1893).

Edessa lineata.

Edessa lineata Westw. in Hope Cat. i. p. 28 (1837).

Allied to *E. saturata* Dall., differing by the unicolorous connexivum and the non-apically excavated scutellum.

Edessa miniata.

Edessa miniata Westw. in Hope Cat. i. p. 28 (1837).

Edessa scutellata Herr.-Schäff. Wanz. Ins. v. p. 101, fig. 552 (1839); Stål, En. Hem. ii. p. 55. n. 36 (1872).

Var. *Edessa lurida* Dall. List Hem. i. p. 328. n. 28 (1851); Stoll, Pun. fig. 148.

Edessa flavida.

Edessa flavida Westw. in Hope Cat. i. p. 28 (1837); Stål, En. Hem. ii. p. 53. n. 21 (1872).

Edessa lutea Westw. in Hope Cat. i. p. 28 (1837).

Edessa simplex Herr.-Schäff. Wanz. Ins. v. p. 103, fig. 554 (1839).

Edessa jutea Stål, En. Hem. ii. p. 59. n. 76 (1872).

This is quite distinct from the species recorded as *E. flavida* and *E. lutea* by Dallas.

Edessa carnosa.

Edessa carnosa Westw. in Hope Cat. i. p. 29 (1837).

Aceratodes costalis Stål, Eug. Resa, Ins. p. 231. n. 29 (1859).

Edessa senilis Walk. Cat. Het. iii. p. 450. n. 128 (1868).

Edessa fulvipes var. *costalis* Stål, En. Hem. ii. p. 58 (1872); Dist. Biol. Centr.-Amer., Rhyn. vol. i. p. 458. n. 39 (b) (1893).

Var. *Aceratodes fulvipes* Dall. List Hem. i. p. 335. n. 6 (1851).

The form *costalis* Stål has hitherto been recorded as the variety of *E. fulvipes* Dall. Now that Stål's *costalis* is found to be synonymic with *E. carnosa* Westw. the oldest name, the subsequently described *E. fulvipes* Dall. must be regarded as the varietal form.

Subfam. Asopinæ.

Dorycoris fuscosus.

Asopus fuscosus Germ. in Silberm. Rev. v. p. 187 (1837).

Pentatoma miniata Westw. in Hope Cat. i. p. 43 (1837).

Both these descriptions were published in the year 1837, and there is no evidence as to which appeared first. The species has been hitherto known and recorded under Germar's name, and it is therefore better to make no alteration.

Audinetia spinidens.

Cimex spinidens Fabr. Mant. Ins. ii. p. 285 (1787).

Pentatoma aliena Westw. in Hope Cat. i. p. 40 (1837).

Glypsus sparsus. (Plate LIII. fig. 5.)

Ælia sparsa Westw. in Hope Cat. i. p. 33 (1837).
Ælia assimilis Westw. loc. cit.

Podisus neglectus. (Plate LIII. fig. 4.)

Raphigaster neglectus Westw. in Hope Cat. i. p. 31 (1837).
Podisus neglectus Stål, En. Hem. i. p. 53. n. 29 (1870).

Subfam. Tessaratominæ.

Tessaratoma papillosa.

Cimex papillosus Drury, Ill. Nat. Hist. i. p. 96, tab. 43. fig. 2 (1770).
Tesseratoma proxima Westw. in Hope Cat. i. p. 27 (1837).

Stål (En. Hem. i. p. 67, 1870) treats *T. proxima* as a synonym of *T. javanica* Thunb., restricting *T. papillosa* to China only. This, in my view, is clearly incorrect.

Subfam. Phyllocephalinæ.

Melampodius, gen. nov.

Head with the lateral lobes very much longer than the central, projecting forward and somewhat upward, their apices wide apart; ocelli placed very close to the eyes. Antennæ of five joints; basal joint very stout, reaching to about half the length of the lateral lobes; apical joint somewhat thickened. Rostrum passing the anterior coxæ, stout, third joint longest. Pronotum with the lateral angles produced forward in long, slightly diverging horns, which are strongly toothed internally. Scutellum broad, narrowed about midway to apex. Membrane with longitudinal veins. Legs stout and pilose.
Allied to *Cressona* Dall.

Melampodius cervicornis. (Plate LIII. fig. 10.)

Atelocerus cervicornis Westw. in Hope Cat. i. p. 21 (1837).
Hab. Sierra Leone.

Basicryptus irroratus. (Plate LIII. fig. 6.)

Phyllocephala irrorata Westw. in Hope Cat. i. p. 27 (1837).

Subfam. Acanthosominæ.

Acanthosoma lateralis.

Edessa lateralis Say, New Harm. Ind., Dec. 1831; Compl. Writ. i. p. 312. n. 2 (1859).
Acanthosoma affinis Westw. in Hope Cat. i. p. 30 (1837).
Acanthosoma picicolor Westw. loc. cit.

ACANTHOSOMA CRUCIATA.

Edessa cruciata Say, New Harm. Ind., Dec. 1831; Compl. Writ. i. p. 311 (1859).

Acanthosoma borealis Westw. in Hope Cat. i. p. 30 (1837).

SASTRAGALA VARIOLOSA. (Plate LIII. fig. 3.)

Acanthosoma variolosa Westw. in Hope Cat. i. p. 30 (1837).

A species allied to *S. binotata* Dist.

SPECIES OF UNCERTAIN POSITION.

—— ? ATRICORNIS. (Plate LIII. fig. 8.)

Ælia atricornis Westw. in Hope Cat. i. p. 32 (1837).

I do not quite see my way to generically locate this species. The antennæ are in too mutilated a condition for the foundation of a new genus, and as the species is now figured, it will be well to wait for more perfect material before deciding its classificatory position.

—— ? NIGRIPES.

Pentatoma nigripes Westw. in Hope Cat. i. p. 41 (1837).

The solitary type specimen is without abdomen and lacking also half the scutellum. It is thus in too mutilated a condition for figuring or for generic identification.

—— ? HARRISI. (Plate LIII. fig. 2.)

Pentatoma harrisii Westw. in Hope Cat. i. p. 41 (1837).

Westwood gives the habitat of this species as "*Georgia Americæ*," a locality we have already seen, as in his *P. pantherina* = *Antestia cruciata*, he had applied to an Oriental species. I can find no trace of this species in the descriptions of North-American Pentatomidæ, which are now presumably fairly complete, and am inclined to consider that the locality is also incorrect. It is therefore perhaps better to figure the species and leave the genus an open question till its locality is authenticated.

—— ? LATERALIS. (Plate LIII. fig. 9.)

Pentatoma lateralis Westw. in Hope Cat. i. p. 43 (1837).

The typical and only specimen is in a bad condition, with the rostrum wholly absent. Generic identification is thus impossible.

Summarized Disposition of the Hopeian Genera and Species.

PENTATOMIDÆ.

NEW GENERA DESCRIBED.

Plataspis Westw. in Hope Cat. i. p. 16 (1837).
Hoplistodera Westw. loc. cit. p. 18.
Aplosterna Westw. loc. cit. p. 26.
Lyramorpha Westw. loc. cit. p. 27.
Rhynchocoris Westw. loc. cit. p. 29.
Urolabida Westw. loc. cit. p. 45.
Urostylis Westw. loc. cit.

Species and Genera remaining undisturbed.

Podops spinifera Westw. in Hope Cat. i. p. 16.
Plataspis nigrita Westw. loc. cit. p. 17.
Coptosoma maculata Westw. loc. cit.
,, *transversa* Westw. loc. cit.
,, *nepalensis* Westw. loc. cit.
Hoplistodera testacea Westw. loc. cit. p. 18.
Cydnus indicus Westw. loc. cit. p. 19.
,, *insularis* Westw. loc. cit.
,, *obscurus* Westw. loc. cit.
,, *capicola* Westw. loc. cit.
,, *nigricans* Westw. loc. cit.
,, *nepalensis* Westw. loc. cit.
Megarhynchus truncatus Westw. loc. cit. p. 20.
Atelocerus sticticus Westw. loc. cit. (*Atelocera stictica*).
Aspongopus ochreus Westw. loc. cit. p. 25.
,, *nubilus* Westw. loc. cit.
,, *cuprifer* Westw. loc. cit.
,, *nigriventris* Westw. loc. cit. p. 26.
,, *sanguinolentus* Westw. loc. cit.
,, *fuscus* Westw. loc. cit.
,, *nepalensis* Westw. loc. cit.
Megymenum insulare Westw. loc. cit.
Aplosterna virescens Westw. loc. cit. p. 27.
Lyramorpha rosea Westw. loc. cit. p. 28.
Edessa lineata Westw. loc. cit. p. 28.
,, *jugata* Westw. loc. cit.
,, *flavida* Westw. loc. cit.
,, *miniata* Westw. loc. cit.
,, *loxdalii* Westw. loc. cit. p. 29.
,, *piperitia* Westw. loc. cit.
,, *carnosa* Westw. loc. cit.
Urolabida tenera Westw. loc. cit. p. 45.
Urostylis punctigera Westw. loc. cit.

Species requiring Generic revision.

Trigonosoma subfasciatum Westw. in Hope Cat. i. p. 11,	belongs	to genus	*Hotea*.
,, *gambiæ* Westw. loc. cit.	,,	,,	,,
,, *affine* Westw. loc. cit. p. 12	,,	,,	*Ancyrosoma*.
,, *rufum* Westw. loc. cit.	,,	,,	*Bolbocoris*.
Scutellera rubro-lineata Westw. loc. cit.	,,	,,	*Graphosoma*.
Pachycoris lobata Westw. loc. cit.	,,	,,	*Lobothyreus*.
,, *attenuata* Westw. loc. cit. p. 13		,,	*Solenostethium*
Sphærocoris lateritia Westw. loc. cit.	,,	,,	*Hyperoncus*.
Tectocoris hardwickii Westw. loc. cit.	,,	,,	*Pœcilocoris*.
,, *purpurascens* Westw. loc. cit.	,,	,,	,,
,, *interrupta* Westw. loc. cit. p. 14	,,	,,	,,
,, *oblonga* Westw. loc. cit.	,,	,,	*Brachyaulax*.

Callidea purpurea Westw. loc. cit. p. 15	belongs	to genus	*Chrysocoris*.
,, *marginella* Westw. loc. cit.	,,	,,	,,
,, *obtusa* Westw. loc. cit. p. 16	,,	,,	*Lamprocoris*.
,, *roylii* Westw. loc. cit.	,,	,,	,,
,, *purpurata* Westw. loc. cit.	,,	,,	*Cantao*.
Plataspis hemisphærica Westw. loc. cit. p. 17		,,	*Brachyplatys*.
,, *nitida* Westw. loc. cit.	,,	,,	,,
,, *subænea* Westw. loc. cit.	,,	,,	,,
,, *nigriventris* Westw. loc. cit. p. 18		,,	,,
Cydnus piceus Westw. loc. cit. p. 18	,,	,,	*Adrisa*.
,, *latipes* Westw. loc. cit.	,,	,,	*Scoparipes*.
,, *serripes* Westw. loc. cit. p. 19	,,	,,	*Pangæus*.
,, *subferrugineus* Westw. loc. cit.	,,	,,	*Amnestus*.
Megarhynchus acanthurus Westw. loc. cit. p. 20		,,	*Diploxys*.
Atelocerus furcatus Westw. loc. cit.	,,	,,	*Diplorhinus*.
,, *centro-lineatus* Westw. loc. cit.	,,	,,	*Omyta*.
,, *rugosus* Westw. loc. cit. p. 21	,,	,,	*Orthoschizops*?
,, *cervicornis* Westw. loc. cit.	,,	,,	*Melampodius*, g. n.
,, *varicornis* Westw. loc. cit.	,,	,,	*Alcæus*.
,, *variegatus* Westw. loc. cit.	,,	,,	*Ætius*, g. n.
Halys assimilis Westw. loc. cit. p. 21	,,	,,	*Orthoschizops*.
,, *parvula* Westw. loc. cit. p. 22	,,	,,	*Spudæus*.
,, *nigricollis* Westw. loc. cit.	,,	,,	*Dalpada*.
,, *alternans* Westw. loc. cit.	,,	,,	*Nevisanus*.
,, *lata* Westw. loc. cit. p. 23	,,	,,	*Atelocera*.
,, *apicalis* Westw. loc. cit.	,,	,,	*Eumecopus*.
,, *strigata* Westw. loc. cit.	,,	,,	*Pœcilometis*.
,, *reticulata* Westw. loc. cit. p. 24	,,	,,	*Spudæus*.
,, *lineata* Westw. loc. cit.	,,	,,	*Pœcilometis*.
Dinidor melanoleucus Westw. loc. cit.	,,	,,	*Dinocoris*.
,, *tesselatus* Westw. loc. cit.	,,	,,	,,
,, *variolosus* Westw. loc. cit. p. 25	,,	,,	,,
,, *dispar* Westw. loc. cit.	,,	,,	*Hyrmine*.
,, *unicolor* Westw. loc. cit.		,,	*Dinocoris*.
Aspongopus siccifolius Westw. loc. cit.	,,	,,	*Cyclopelta*.
Phyllocephala irrorata Westw. loc. cit. p. 27		,,	*Basicryptus*.
Eusthenes laticollis Westw. loc. cit.	,,	,,	*Mattiphus*.
Tesseratoma cuprea Westw. loc. cit.	,,	,,	*Eusthenes*.
,, *taurus* Westw. loc. cit.	,,	,,	*Emblosterna*.
Edessa nodifera Westw. loc. cit. p. 28	,,	,,	*Peromatus*.
Rhynchocoris inquinata Westw. loc. cit. p. 29		,,	*Avicenna*, g. n.
,, *unimaculata* Westw. loc. cit.	,,	,,	*Ocirrhoë*?
,, *thoracica* Westw. loc. cit. p. 30		,,	*Cuspicona*.
,, *roeii* Westw. loc. cit.	,,	,,	*Ocirrhoë*.
Acanthosoma variolosa Westw. loc. cit.	,,	,,	*Sastragala*.
Raphigaster neglectus Westw. loc. cit. p. 31		,,	*Podisus*.
,, *luteus* Westw. loc. cit.	,,	,,	*Platacantha*.
,, *guildingii* Westw. loc. cit.	,,	,,	*Piezodorus*.
,, *flavolineatus* Westw. loc. cit.	,,	,,	,,

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Raphigaster virescens Westw. loc. cit.	belongs	to	genus	*Ocirrhoë*?
,, *monsoni* Westw. loc. cit.	,,		,,	*Cresphontes.*
,, *longitudinalis* Westw. loc. cit.	,,		,,	*Axona.*
Ælia nasalis Westw. loc. cit. p. 32	,,		,,	*Cermatulus.*
,, *erosa* Westw. loc. cit. p. 33	,,		,,	*Agonoscelis.*
,, *melanoleuca* Westw. loc. cit.	,,		,,	*Platynopus.*
,, *sparsa* Westw. loc. cit.	,,		,,	*Glypsus.*
,, *conspicua* Westw. loc. cit.	,,		,,	,,
,, *varicornis* Westw. loc. cit.	,,		,,	*Kalula*, g. n.
Pentatoma formosa Westw. loc. cit. p. 34	,,		,,	*Menida.*
,, *violascens* Westw. loc. cit.	,,		,,	*Murgantia.*
,, *gloriosa* Westw. loc. cit.	,,		,,	*Stenozygum.*
,, *varia* Westw. loc. cit.	,,		,,	,,
,, *deplanata* Westw. loc. cit. p. 35	,,		,,	*Tropicorypha.*
,, *obscura* Westw. loc. cit.	,,		,,	*Carbula.*
,, *difficilis* Westw. loc. cit.	,,		,,	,,
,, *subferruginea* Westw. loc. cit.	,,		,,	*Niphe.*
,, *viridicollis* Westw. loc. cit.	,,		,,	*Plautia.*
,, *ventralis* Westw. loc. cit. p. 36	,,		,,	*Eysarcoris.*
,, *lineaticollis* Westw. loc. cit.	,,		,,	*Æliomorpha.*
,, *caffræ* Westw. loc. cit.	,,		,,	,,
,, *antiguensis* Westw. loc. cit.	,,		,,	*Thyanta.*
,, *vitrea* Westw. loc. cit.	,,		,,	,,
,, *albo-notata* Westw. loc. cit. p. 37			,,	*Actuarius*, g. n.
,, *varicolor* Westw. loc. cit.	,,		,,	*Murgantia.*
,, *marginalis* Westw. loc. cit.	,,		,,	*Oplomus.*
,, *scutellata* Westw. loc. cit.	,,		,,	*Mormidea.*
,, *chloris* Westw. loc. cit. p. 38	,,		,,	*Nezara.*
,, *chlorocephala* Westw. loc. cit.	,,		,,	,,
,, *capicola* Westw. loc. cit. p. 39	,,		,,	,,
,, *crassa* Westw. loc. cit.	,,		,,	*Zangis.*
,, *pavonina* Westw. loc. cit.	,,		,,	*Dorycoris.*
,, *bronzea* Westw. loc. cit. p. 40	,,		,,	,,
,, *luteipennis* Westw. loc. cit.	,,		,,	*Loxa.*
,, *atrox* Westw. loc. cit.	,,		,,	*Euchistus.*
,, *crocipes* Westw. loc. cit.	,,		,,	,,
,, *3-maculata* Westw. loc. cit.	,,		,,	*Dalpada.*
,, *3-notata* Westw. loc. cit.	,,		,,	*Tolumnia.*
,, *unicolor* Westw. loc. cit. p. 41	,,		,,	*Palomena.*
,, *pallescens* Westw. loc. cit.	,,		,,	*Ilerda.*
,, *pallipes* Westw. loc. cit.	,,		,,	*Dictyotus.*
,, *roei* Westw. loc. cit. p. 42	,,		,,	,,
,, *indica* Westw. loc. cit.	,,		,,	*Carbula.*
,, *semimarginata* Westw. loc. cit.	,,		,,	*Dictyotus.*
,, *cœnosa* Westw. loc. cit.	,,		,,	,,
,, *purpurea* Westw. loc. cit. p. 43	,,		,,	*Afrius.*
,, *varipennis* Westw. loc. cit.	,,		,,	*Menida.*
,, *platygaster* Westw. loc. cit.	,,		,,	*Candace.*
,, *aculeata* Westw. loc. cit. p. 44	,,		,,	*Myrochea.*
,, *rufo-spilota* Westw. loc. cit.	,,		,,	*Lincus.*

Pentatoma rugicollis Westw. loc. cit. belongs to genus *Basicryptus*.
,, *cummingii* Westw. loc. cit. ,, ,, *Ditomotarsus*.
,, *marginella* Westw. loc. cit. p. 45 ,, *Lubentius*.
,, *luteo-varia* Westw. loc. cit. ,, ,, *Anischys*.
Urostylis histrionica Westw. loc. cit. p. 46 ,, ,, *Urolabida*.

SPECIES TREATED AS SYNONYMIC.

Eurygaster cognatus Westw. in Hope = *Eurygaster maurus* Linn.
[Cat. i. p. 11.
,, *orientalis* Westw. l. c. = *E. maurus* Linn., var. *pictus*
[Fabr.
Trigonosoma apicale Westw. l. c. = *Hotea gambiæ* Westw.
Agonosoma bicolor Westw. l. c. p. 12 = *Agonosoma trilineata* Fabr.,
[var.
Pachycoris linnæi Westw. l. c. = *Pachycoris torridus* Scop., var.
,, *niteus* Westw. l. c. = *Pachycoris fabricii* Linn., var.
,, *pumila* Westw. l. c. = ,, ,, ,,
,, *flavescens* Westw. l. c. = *Diolcus irroratus* Fabr.
,, *piperitia* Westw. l. c. p. 13 = *Ascanius hirtipes* Herr.-Sch.
Sphærocoris annularis Westw. l. c. = *Sphærocoris annulus* Fabr.
,, *punctaria* Westw. l. c. = *Sphærocoris testudo-grisea*
[De Geer, var.
,, 4-*notata* Westw. l. c. = *Steganocerus multipunctatus*
[Thunb., var.
,, *polysticta* Westw. l. c. = *Sphærocoris testudo-grisea*
[De Geer, var.
Tectocoris affinis Westw. l. c. = *Pœcilocoris hardwickii* Westw.
,, *gambiæ* Westw. l. c. p. 14 = *Tectocoris lineola* Fabr., var.
,, *javana* Westw. l. c. = *Chrysocoris atricapillus* Guér.
,, *nepalensis* Westw. l. c. = *Scutellera fasciata* Panz.
,, *obscura* Westw. l. c. = *Calliphara excellens* Burm.
,, *binotata* Westw. l. c. p. 15 = *Philea senator* Fabr., var.
Callidea abdominalis Westw. l. c. = *Chrysocoris dilaticollis* Guér.
,, *formosa* Westw. l. c. = *Chrysocoris eques* Fabr., var.
,, *taprobanensis* Westw. l. c. = *Chrysocoris stockerus* Linn.
,, *aurifera* Westw. l. c. = *Chrysocoris auratus* Guér.
,, *bengalensis* Westw. l. c. = *Chrysocoris patricius* Fabr.
,, *dispar* Westw. l. c. p. 16 = *Cantao ocellatus* Thunb.
,, *regia* Westw. l. c. = *Calliphara imperialis*.
,, *pulchra* Westw. l. c. = *Graptophara reynaudii* Guér.
Augocoris gigas Westw. l. c. = *Augocoris gomesi* Burm.
Plataspis flaviceps Westw. l. c. p. 17 = *Brachyplatys flavipes* Fabr.
Stiretrus rubro-maculatus Westw. = *Stiretrus decemguttatus* Lep. &
[l. c. p. 18. [Serv.
Sciocoris capensis Westw. l. c. = *Pododus orbicularis* Burm.
Megarhynchus 4-*spinosus* Westw. = *Tetroda histeroides* Fabr.
[l. c. p. 19.
,, *marginellus* Westw. = *Macrina juvenca* Burm.
[l. c. p. 20.

Halys humeralis Westw. l. c. p. 21 = *Euoplitus laciniatus* Spin.
„ *carolinensis* Westw. l. c. p. 22 = *Brochymena annulata* Fabr.
„ *timorensis* Westw. l. c. = *Halyomorpha picus* Fabr.
„ *obscura* Westw. l. c. = *Dalpada nigricollis* Westw.
„ *serrigera* Westw. l. c. p. 23 = *Halys dentata* Fabr.
„ *concinna* Westw. l. c. = *Dalpada clavata* Fabr.
„ *serricollis* Westw. l. c. = *Halys dentata* Fabr.
„ *latipes* Westw. l. c. = *Dalpada clavata* Fabr.
Dinidor punctiger Westw. l. c. p. 25 = *Dinocoris tripterus* Fabr.
Aspongopus vicinus Westw. l. c. = *Aspongopus janus* Fabr.
„ *alternans* Westw. l. c. [p. 26. = *Cyclopelta obscura* Lep. & [Serv.
Tesseratoma proxima Westw. l. c. [p. 27. = *Tessaratoma papillosa* Dru.
Lyramorpha pallida Westw. l. c. [p. 28. = *Lyramorpha rosea* Westw.
Edessa lutea Westw. l. c. = *Edessa flavida* Westw.
„ *vicina* Westw. l. c. p. 29 = *Piezosternum calidum* Fabr.
Acanthosoma luteicornis Westw. l. c. [p. 30. = *Arvelius albopunctatus* De [Geer.
„ *picicolor* Westw. l. c. = *Acanthosoma lateralis* Say.
„ *affinis* Westw. l. c. = „ „
„ *borealis* Westw. l. c. = *Acanthosoma cruciata* Say.
Raphigaster transversalis Westw. [l. c. p. 31. = *Platacantha lutea* Westw.
„ *punctulatus* Westw. l. c. = *Piezodorus incarnatus* Germ.
„ *abdominalis* Westw. l. c. [p. 32. = *Vulsirea violacea* Fabr.
Ælia crucifera Westw. l. c. = *Agonoscelis nubila* Fabr.
„ *sanguinea* Westw. l. c. = *Agonoscelis venosa* Thunb.
„ *gambiensis* Westw. l. c. = *Agonoscelis versicolor* Fabr.
„ *infuscata* Westw. l. c. = „ „
„ *depressa* Westw. l. c. = *Dolycoris baccarum* Linn.
„ *assimilis* Westw. l. c. p. 33 = *Glypsus sparsus* Westw.
Pentatoma æquinoxialis Westw. l. c. = *Arocera acroleuca* Perty.
„ *nitida* Westw. l. c. = *Nezara marginalis* Herr.-Sch.
„ *pantherina* Westw. l. c. [p. 34. = *Antestia cruciata* Fabr.
„ *binotata* Westw. l. c. = *Dismegistus sanguineus* De [Geer.
„ *wilkinsonii* Westw. l. c. [p. 35. = *Carpocoris nigricornis* Fabr.
„ *bimaculata* Westw. l. c. = *Carbula insocia* Walk.
„ *pennsylvaniæ* Westw. l. c. = *Hymenarcys nervosa* Say.
„ *orbitalis* Westw. l. c. = *Antestia variegata* Thunb.
„ *nepalensis* Westw. l. c. [p. 36. = *Eysarcoris guttiger* Thunb.
„ *punctipes* Westw. l. c. = „ „
„ *bengalensis* Westw. l. c. = *Menida histrio* Fabr.

Horace Knight del. et lith.

West, Newman chromo

RHYNCHOTA OF THE FAMILY PENTATOMIDÆ

Horace Knight del et lith. West, Newman chromo.

RHYNCHOTA OF THE FAMILY PENTATOMIDÆ.

[*From the* PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON, April 16, 1901.]

Revision of the Rhynchota belonging to the Family *Coreidæ* in the Hope Collection at Oxford. By W. L. DISTANT.

(Plates XXIX. & XXX.[2])

This communication concludes the revision of the Rhynchota briefly described by the late Prof. Westwood in the only two parts published of "A Catalogue of Hemiptera in the Collection of the Rev. F. W. Hope," which forms an integral portion of the well-known "Hope Collection" at Oxford. I have now, by the kind permission of Prof. Poulton, examined the *Coreidæ* which

[2] For explanation of the Plates, see p. 335.

constitute the material described in the second part of that Catalogue; the revision of the Pentatomidæ treated in the first part, the Society has already done me the honour to publish in their 'Proceedings' (1900, p. 807). The introductory remarks there given are also applicable to this concluding instalment and need not be repeated.

Owing to the very attenuated descriptions given in these catalogues, considerable synonymy has been created by other workers, which under the circumstances may cause regret but no surprise.

Subfam. MICTINÆ.

MELANIA, gen. nov.

♀. Body oblong, compressed. Head subquadrate, distinctly excavated between the apices of the lateral lobes; antennæ simple, third joint not dilated, first and fourth joints subequal in length; rostrum passing the anterior coxæ, third joint shortest; pronotum about as long as broad at base, lateral margins not denticulated, lateral angles not produced. Abdomen distinctly broader than corium, its lateral margins dentate, apical angles of second, third, fourth, fifth, and sixth abdominal segments distinctly spinous; abdomen beneath at junction of second and third abdominal segments armed with two long diverging spines. Posterior femora wide apart, regularly incrassated, about equally thick throughout, armed above and on sides with four series of spinous tubercles, and with a short but robust spine near apex beneath; posterior tibiæ dilated on each side, convexly outwardly, and angulately and truncately narrowed on inner margin at about one fourth from apex.

This genus is allied to *Pternistria*, *Cipia*, and *Odontoloba*, from all of which, apart from other characters, it may be separated by the dentate lateral margins of the abdomen and the spinous apical angles of the abdominal segments. The tuberculated posterior femora reflect a character in *Prionolomia*. In the female the posterior tibiæ are simple, the posterior femora less tuberculate than in the male, the abdomen unarmed, and the abdominal margins much less denticulate and spinous than in the other sex.

MELANIA GRACILIS. (Plate XXIX. fig. 4, ♀.)

♀. *Myctis gracilis* Westw. in Hope Cat. ii. p. 11 (1842).

♂. Dark castaneous, finely ochraceously pilose; connexivum piceous; eyes, abdominal spines, apex of scutellum, and subquadrate spots to connexivum pale ochraceous; antennæ, anterior and intermediate legs, and the posterior tarsi ochraceous. Abdomen above black, with two discal longitudinal series of ochraceous spots.

The antennæ have the first and fourth joints subequal in length, the second a little longer than the third, the first and fourth longest; the pronotum is granulate and coarsely punctate; the scutellum is irregularly transversely rugose, its apex levigate; the

corium is thickly and finely punctate: the lateral areas of the pro- and mesosterna, the centre of the mesosternum and the disks of the metasternum, and first, second, and third abdominal segments are thickly ochraceously pilose, the sternum coarsely punctate, the abdomen finely tuberculate; other structural characters as detailed in generic diagnosis.

Long. ♂ 25 millim. Exp. pronot. angl. 6½ millim. Max. abdom. lat. 8½ millim.

Hab. Java (Hope Mus. Oxon. ♀); Singapore (Atkinson Coll. Brit. Mus. ♂).

In the female (figured) the body beneath is more uniformly greyish or ochraceously pilose than in the other sex.

MICTIS TENEBROSA.

Lygæus tenebrosus Fabr. Mant. ii. p. 288 (1787).
Myctis fasciatus Westw. in Hope Cat. ii. p. 11 (1842).

ANOPLOCNEMIS PHASIANUS.

Lygæus phasianus Fabr. Spec. ii. p. 361 (1781).
Myctis punctum Westw. in Hope Cat. ii. p. 10 (1842).
Myctis affinis Westw. loc. cit.
Myctis bicolor Westw. loc. cit.

ANOPLOCNEMIS VARICORNIS. (Plate XXIX. fig. 3.)

Myctis varicornis Westw. in Hope Cat. ii. p. 12 (1842).

ANOPLOCNEMIS FUSCUS.

Myctis fuscus Westw. in Hope Cat. ii. p. 13 (1842).
Myctis ventralis Westw. loc. cit.
Mictis similis Dall. List Hem. ii. p. 387. n. 4 (1852).

PACHYLIS LATICORNIS.

Lygæus laticornis Fabr. Ent. Syst. Suppl. p. 538. n. 15 (1798).
Pachylis grossus Westw. in Hope Cat. ii. p. 13 (1842).
Thasus grossus Stål, En. Hem. i. p. 133. n. 4 (1870); Leth & Serv. Cat. Gén. Hém. t. ii. p. 14 (1894).

Westwood's type is a unique specimen, a dark variety, and in bad condition. Along with it were mixed up some specimens of *Thasus heteropus* Latr. var. This is the circumstance which probably misled Stål as to the genus (*supra*).

NEMATOPUS NERVOSUS.

Nematopus nervosus Lap. Ess. Hém. p. 30 (1832).
Nematopus ventralis Westw. in Hope Cat. ii. p. 14 (1842) (♀).
Nematopus punctiger Dall. List Hem. ii. p. 427. n. 13 (1852) (♀).

Stål (En. Hem. i. p. 142) rightly opined of the *N. ventralis* Westw., "an femina *N. nervosi* ?"; this is also the sex of *N. punctiger* Dall., and both agree with the female specimen of *N. nervosus* which I recorded from Panama (Biol. Centr.-Amer., Rhynch. i. p. 357).

Subfam. Amorbinæ.

Amorbus bispinus.

Physomerus bispinus Westw. in Hope Cat. ii. p. 9 (1842).

Amorbus rhombifer.

Physomerus rhombifer Westw. in Hope Cat. ii. p. 9 (1842).
Amorbus rhombeus Dall. (nec Westw.) List Hem. ii. p. 411. n. 7 (1852).

Amorbus rhombeus.

Physomerus rhombeus Westw. in Hope Cat. ii. p. 10 (1842).
Amorbus rhombifer Dall. (nec Westw.) List Hem. ii. p. 411. n. 8 (1852).

A. rhombifer and *A. rhombeus* are very closely allied and doubtfully distinct. Beyond a generally darker hue and greater incrassation of the posterior femora in the male of *A. rhombeus*, there is scarcely a character to separate the two forms.

Amorbus angustior. (Plate XXIX. fig. 2.)

Physomerus angustior Westw. in Hope Cat. ii. p. 9 (1842).

This species can be separated from *A. obscuricornis* Westw., to which it is closely allied, by the colour of the posterior tibiæ. Dr. Mayr (Reise Novara, Hem. pp. 86–7) separates the species by the colour of the antennæ, and by the presence or absence of a small black apical spot on the red upper surface of the abdomen. These characters are, however, both inconstant, and this distinctlion cannot be maintained. Westwood omitted to describe the colour of the posterior tibiæ in his *A. angustior*, but the unique type is now figured.

Amorbus subserratus. (Plate XXIX. fig. 5.)

Physomerus subserratus Westw.

The only really distinguishing feature of this species from the above is found in the character described by Westwood as "tibiisque pone angulum medium marginis interni 4-serratis."

Subfam. Daladerinæ.

Dalader rubiginosus.

Acanonicus rubiginosus Westw. in Hope Cat. ii. p. 8 (1842).
Dalader parvulus Dist. Ann. Mag. Nat. Hist. (6) xii. p. 122 (1893).

Subfam. Acanthocephalinæ.

Acanthocephala unicolor.

Metapodius unicolor Westw. in Hope Cat. ii. p. 15 (1842).
Metapodius distincta Walk. Cat. Het. iv. p. 50. n. 21 (1871).

Connexivum brownish ochraceous. A species allied to *A. granulosa* Dall.

ACANTHOCEPHALA FEMORATA.

Cimex femoratus Fabr. Syst. Ent. p. 708 (1775).
Metapodius bispinus Westw. in Hope Cat. ii. p. 15 (1842).

ACANTHOCEPHALA ÆQUALIS. (Plate XXIX. fig. 1.)

Metapodius equalis Westw. in Hope Cat. ii. p. 14 (1842).

Allied to *A. latipes* Dru., from which it differs by the more attenuated and less notched posterior tibiæ.

ACANTHOCEPHALA CONSOBRINA. (Plate XXIX. fig. 7.)

Metapodius consobrinus Westw. in Hope Cat. ii. p. 15 (1842).
Metapodius nigricans Westw. loc. cit.

Westwood's types are unlocalized; the British Museum also possesses two specimens of the species, but both without habitats.

ACANTHOCEPHALA APICALIS.

Metapodius apicalis Westw. in Hope Cat. ii. p. 15 (1842).

Form and size of *A. consobrina*, pronotal angles less produced, colour different, &c.

ACANTHOCEPHALA ANGUSTIPES.

Metapodius angustipes Westw. in Hope Cat. ii. p. 15 (1842).
Metapodius constrictus Walk. Cat. Het. iv. p. 47. n. 4 (1871).

Westwood's type is unlocalized; Walker's typical specimen is from Barbadoes; another specimen in the British Museum is from Cayenne. The Colombian specimen identified by Dallas (List Hem. ii. p. 430. n. 6, 1852) as *A. angustipes* is not Westwood's species.

EMPEDOCLES TENUICORNIS. (Plate XXX. fig. 1.)

Metapodius tenuicornis Westw. in Hope Cat. ii. p. 16 (1842).
Empedocles tenuicornis Stål, En. Hem. i. p. 152 (1870).

Both Westwood's type and Stål's representative are unlocalized, so that the habitat of this species is still to be discovered.

STENOSCELIDEA ALBOVARIA. (Plate XXX. fig. 7.)

Stenoscelidea albovaria Westw. in Hope Cat. ii. p. 18 (1842).

Subfam. HOMŒOCERINÆ.

HOMŒOCERUS BIGUTTATA.

Homœocerus 2-guttatus Westw. in Hope Cat. ii. p. 22 (1842).
Homœocerus sikkimensis Dist. Ent. Month. Mag. xxv. p. 231 (1889).

HOMŒOCERUS SERRIFER.

Coreus serrifer Westw. in Hope Cat. ii. p. 24 (1842).
Homœocerus parvulus Walk. Cat. Het. iv. p. 101. n. 32 (1871).
Homœocerus unipunctatus Dall. (nec Thunb.) List Hem. ii. p. 447. n. 11 (1852).

Subfam. CLORESMINÆ.

NOTOBITUS SEXGUTTATUS.

Nematopus 6-guttatus Westw. in Hope Cat. ii. p. 13 (1842).
Nematopus longipes Dall. List Hem. ii. p. 423. n. 2 (1852).

Subfam. COLPURINÆ.

COLPURA VARIPES.

Gonocerus varipes Westw. in Hope Cat. ii. p. 25 (1842).
Lybas annulipes Dall. List Hem. ii. p. 464. n. 2 (1852).

Subfam. ANISOSCELINÆ.

LEPTOGLOSSUS PHYLLOPUS.

Cimex phyllopus Linn. Syst. Nat. ed. XII., i., ii. p. 731 (1767).
Anisoscelis fraterna Westw. in Hope Cat. ii. p. 16 (1842).

LEPTOGLOSSUS FULVICORNIS. (Plate XXX. fig. 4.)

Anisoscelis fulvicornis Westw. in Hope Cat. ii. p. 17 (1842).

Subfam. PHYSOMERINÆ.

ACANTHOCORIS SCABRATOR.

Coreus scabrator Fabr. Syst. Rhyng. p. 195. 19 (1803).
Crinocerus fuscus Westw. (part.) in Hope Cat. ii. p. 21 (1842).

ACANTHOCORIS SCABER.

Cimex scaber Linn. Cent. Ins. rar. p. 17. 43 (1763).
Crinocerus fuscus Westw. (part.) in Hope Cat. ii. p. 21 (1842).

ACANTHOCORIS AFFINIS. (Plate XXIX. fig. 6.)

Crinocerus affinis Westw. in Hope Cat. ii. p. 21 (1842).

The female specimen is figured showing the rugosity of the posterior femora.

Subfam. GONOCERINÆ.

PLINACTHUS BASALIS.

Coreus basalis Westw. in Hope Cat. ii. p. 24 (1842).
Plinacthus peltastes Stål, Stett. ent. Zeit. xxii. p. 144. 1 (1861).

Subfam. PSEUDOPHLŒINÆ.

CERALEPTUS GRACILICORNIS.

Coreus gracilicornis Herr.-Schäff. cont. Panz. Deutschl. Ins. 135. 5, t. 182 (1835).
Arenocoris ? tibialis Westw. in Hope Cat. ii. p. 25 (1842).

CERALEPTUS ÆGYPTIUS.

Arenocoris ? ægyptius Westw. in Hope Cat. ii. p. 25 (1842).

Ceraleptus squalidus Costa, Cimic. regni Neap. Cent. 2 *a*, p. 12, pl. 4. f. 7 (1847).

Horv. (Rev. d'Ent. xvii. p. 278) considers the specific name *obtusus* Brull. (1838) as taking precedence; but I know neither the species nor the description.

Subfam. Leptocorisinæ.

Leptocorisa tipuloides.

Cimex tipuloides de Geer, Mém. iii. p. 354, pl. 35. f. 18 (1773).
Leptocorisa crudelis Westw. in Hope Cat. ii. p. 18 (1842).

Leptocorisa acuta.

Cimex acutus Thunb. Nat. Ins. Sp. ii. p. 34 (1783).
Leptocorisa bengalensis Westw. in Hope Cat. ii. p. 18 (1842).

Subfam. Alydinæ.

Hyalymenus dentatus.

Alydus dentatus Fabr. Syst. Rhyng. p. 249 (1803).
Alydus ichneumoniformis Westw. in Hope Cat. ii. p. 18 (1842).

Megalotomus rufipes.

Alydus rufipes Westw. in Hope Cat. ii. p. 19 (1842).
Alydus consobrinus Westw. loc. cit. p. 20.
Alydus pallescens Stål, Rio Jan. Hem. i. p. 34 (1860).
Alydus debilis Walk. Cat. Het. iv. p. 160. n. 12 (1871).

Megalotomus parvus. (Plate XXX. fig. 5.)

Alydus parvus Westw. in Hope Cat. ii. p. 19 (1842).

Alydus gracilipes Westw. in Hope Cat. ii. p. 20 (1842).

This species is represented only by the unique type, which is in far too mutilated a condition for generic allocation.

Head, pronotum, and prosternum pale castaneous; head beneath and base of prosternum black; a luteous fascia traversing each lateral area of head and prosternum; meso- and metasternum very pale ochraceous. Abdomen wanting.

Alydus simplex Westw. in Hope Cat. ii. p. 18 (1842).

The type and only specimen possesses neither head nor pronotum. Judging from the remaining portion of the body, it is almost certain that this is a synonym of *Megalotomus rufipes* Westw.?

Mirperus torridus.

Alydus torridus Westw. in Hope Cat. ii. p. 20 (1842).
Alydus albidens Westw. loc. cit.

It is very doubtful whether this species can be really separated from *M. jaculus* Thunb. Certainly not by locality, as specimens from both South and West Africa entirely agree. The structure

of the first joint of the antennæ is distinctive in some specimens, but seems to fail when a larger number are examined; the coloration of the antennæ is an entirely variable character.

RIPTORTUS ABDOMINALIS.

Alydus abdominalis Westw. in Hope Cat. ii. p. 19 (1842).
Alydus obscuricornis Dall. List Hem. ii. p. 475 (1852).

Hab. Australia: Port Essington (Brit. Mus.).

The types of Westwood's species are unlocalized. "Habitat in Brasilia?"

Subfam. CORIZINÆ.

CORIZUS ROBUSTUS. (Plate XXX. fig. 2.)

Corizus robustus Westw. in Hope Cat. ii. p. 26 (1842).

CORIZUS VINCENTII. (Plate XXX. fig. 3.)

Corizus vincentii Westw. in Hope Cat. ii. p. 26 (1842).

SERINETHA FRATERNA. (Plate XXX. fig. 6.)

Pyrrhotes fraterna Westw. in Hope Cat. ii. p. 26 (1842).

The unique type is without legs, antennæ, or habitat.

SERINETHA GRISEIVENTRIS.

Pyrrhotes griseiventris Westw. in Hope Cat. ii. p. 26 (1842).
Serinetha chevreuxi Noualhier, Bull. Mus. d'Hist. Nat. Paris, 1898, p. 233.

Stål (Hem. Afr. ii. p. 114) describes this species, of which it is stated "Exemplum typicum Westwoodi haud examinavi," as having the "rostrum coxas posticas attingens." The rostrum, however, is much longer and generally reaches the third abdominal segment. This is the real distinguishing character which separates the species from *S. hæmatica* Germ.

Summarized Disposition of the Hopeian Genera and Species.

COREIDÆ.

GENERA REMAINING UNDISTURBED.

Brachytes Westw. in Hope Cat. ii. p. 8 (1842).
Stenoscelidea Westw. loc. cit. p. 17.

GENUS TREATED AS SYNONYMIC.

Ceratopachys Westw. in Hope Cat. ii. p. 22 (1842) =*Homœocerus* Burm.

SPECIES AND GENERA REMAINING UNDISTURBED.

Menenotus unicolor Westw. in Hope Cat. ii. p. 8 (1842).
Brachytes bicolor Westw. loc. cit.
Myctis (Mictis) longicornis Westw. loc. cit. p. 11.

Nematopus fasciatus Westw. loc. cit. p. 14.
,, *obscurus* Westw. loc. cit.
Leptoscelis tricolor Westw. loc. cit. p. 17.
Stenoscelidea albo-varia Westw. loc. cit. p. 18.
Leptocorisa apicalis Westw. loc. cit.
Homœocerus angulatus Westw. loc. cit. p. 22.
,, *2-guttatus* Westw. loc. cit.
Corizus robustus Westw. loc. cit. p. 26.
,, *vincentii* Westw. loc. cit.

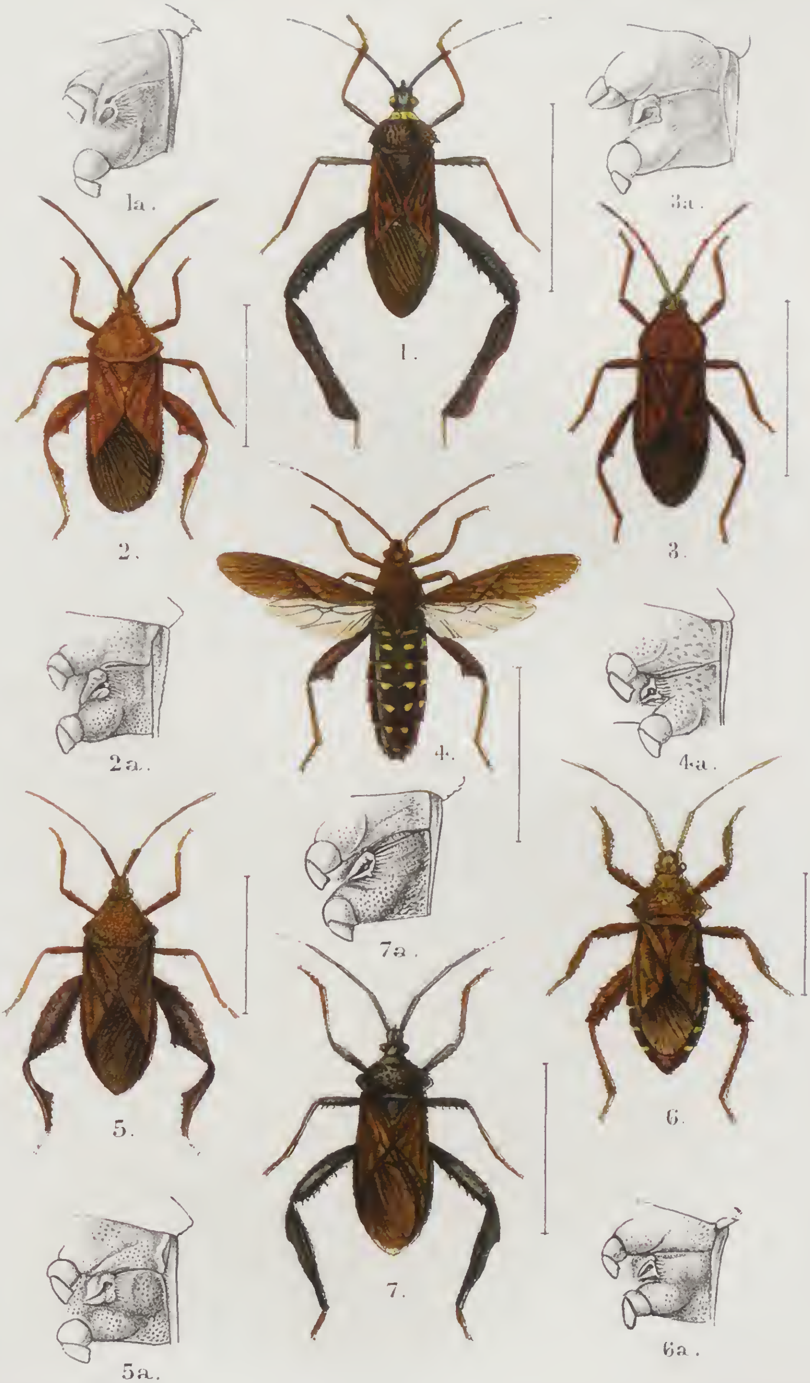
SPECIES REQUIRING GENERIC REVISION.

Spartocerus scutellatus Westw. in Hope Cat. i. p. 7 (1842)	belongs	to genus	*Eubule.*
Acanonicus planiventris Westw. loc. cit. p. 8	,,	,,	*Dalader.*
,, *rubiginosus* Westw. loc. cit.	,,	,,	,,
Physomerus angustior Westw. loc. cit. p. 9	,,	,,	*Amorbus.*
,, *subserratus* Westw. loc. cit.	,,	,,	,,
,, *obscuricornis* Westw. loc. cit.	,,	,,	,,
,, *bispinus* Westw. loc. cit.	,,	,,	,,
,, *rhombifer* Westw. loc. cit.	,,	,,	,,
,, *rhombeus* Westw. loc. cit. p. 10	,,	,,	,,
Myctis lobipes Westw. loc. cit. p. 11	,,	,,	*Petillia.*
,, *albiditarsis* Westw. loc. cit.	,,	,,	*Ochrochira.*
,, *gracilis* Westw. loc. cit.	,,	,,	*Melania*, g. n.
,, *granulipes* Westw. loc. cit.	,,	,,	*Elasmomia.*
,, *alatus* Westw. loc. cit. p. 12	,,	,,	*Holopterna.*
,, *scutellaris* Westw. loc. cit.	,,	,,	*Anoplocnemis.*
,, *varicornis* Westw. loc. cit.	,,	,,	,,
,, *fuscus* Westw. loc. cit. p. 13	,,	,,	,,
Nematopus dorsalis Westw. loc. cit.	,,	,,	*Notobitus.*
,, *6-guttatus* Westw. loc. cit.	,,	,,	,,
,, *marginalis* Westw. loc. cit. p. 14	,,	,,	,,
,, *nepalensis* Westw. loc. cit.	,,	,,	*Cloresmus.*
,, *javanicus* Westw. loc. cit.	,,	,,	,,
Metapodius æqualis Westw. loc. cit.	,,	,,	*Acanthocephala.*
,, *unicolor* Westw. loc. cit. p. 15	,,	,,	,,
,, *apicalis* Westw. loc. cit.	,,	,,	,,
,, *consobrinus* Westw. loc. cit.	,,	,,	,,
,, *angustipes* Westw. loc. cit.	,,	,,	,,
,, *tenuicornis* Westw. loc. cit. p. 16		,,	*Empedocles.*
Anisoscelis quadricollis Westw. loc. cit. p. 17		,,	*Leptoglossus.*
,, *fulvicornis* Westw. loc. cit.	,,	,,	,,
,, *fasciata* Westw. loc. cit.	,,	,,	,,
Alydus parvus Westw. loc. cit. p. 19	,,	,,	*Megalotomus.*
,, *rufipes* Westw. loc. cit.	,,	,,	,,
,, *abdominalis* Westw. loc. cit.	,,	,,	*Riptortus.*
,, *torridus* Westw. loc. cit. p. 20	,,	,,	*Mirperus.*
Hypselonotus centrolineatus Westw. loc. cit. p. 21		,,	*Cebrenis.*
Crinocerus affinis Westw. loc. cit.	,,	,,	*Acanthocoris.*
Chariesterus regalis Westw. loc. cit. p. 22	,,	,,	*Paryphes.*

Homœocerus diversicornis Westw. loc. cit.	belongs	to genus	*Savius*.
Coreus varicornis Westw. loc. cit.	,,	,,	*Anasa*.
,, *apicalis* Westw. loc. cit.	,,	,,	,,
,, *bipunctatus* Westw. loc. cit. p. 23	,,	,,	*Cletus*.
,, *rubidiventris* Westw. loc. cit.	,,	,,	,,
,, *punctulatus* Westw. loc. cit.	,,	,,	,,
,, *capensis* Westw. loc. cit.	,,	,,	,,
,, *basalis* Westw. loc. cit. p. 24	,,	,,	*Plinacthus*.
,, *serrifer* Westw. loc. cit.	,,	,,	*Homœocerus*.
,, *tenuicornis* Westw. loc. cit.	,,	,,	*Hydara*.
,, *scutellaris* Westw. loc. cit.	,,	,,	*Clavigralla*.
Gonocerus varipes Westw. loc. cit. p. 25	,,	,,	*Colpura*.
Arenocoris? ægyptius Westw. loc. cit.	,,	,,	*Ceraleptus*.
Pyrrhotes griseiventris Westw. loc. cit. p. 26		,,	*Serinetha*.
,, *obscura* Westw. loc. cit.	,,	,,	*Jadera*.
,, *fraterna* Westw. loc. cit.	,,	,,	*Serinetha*.

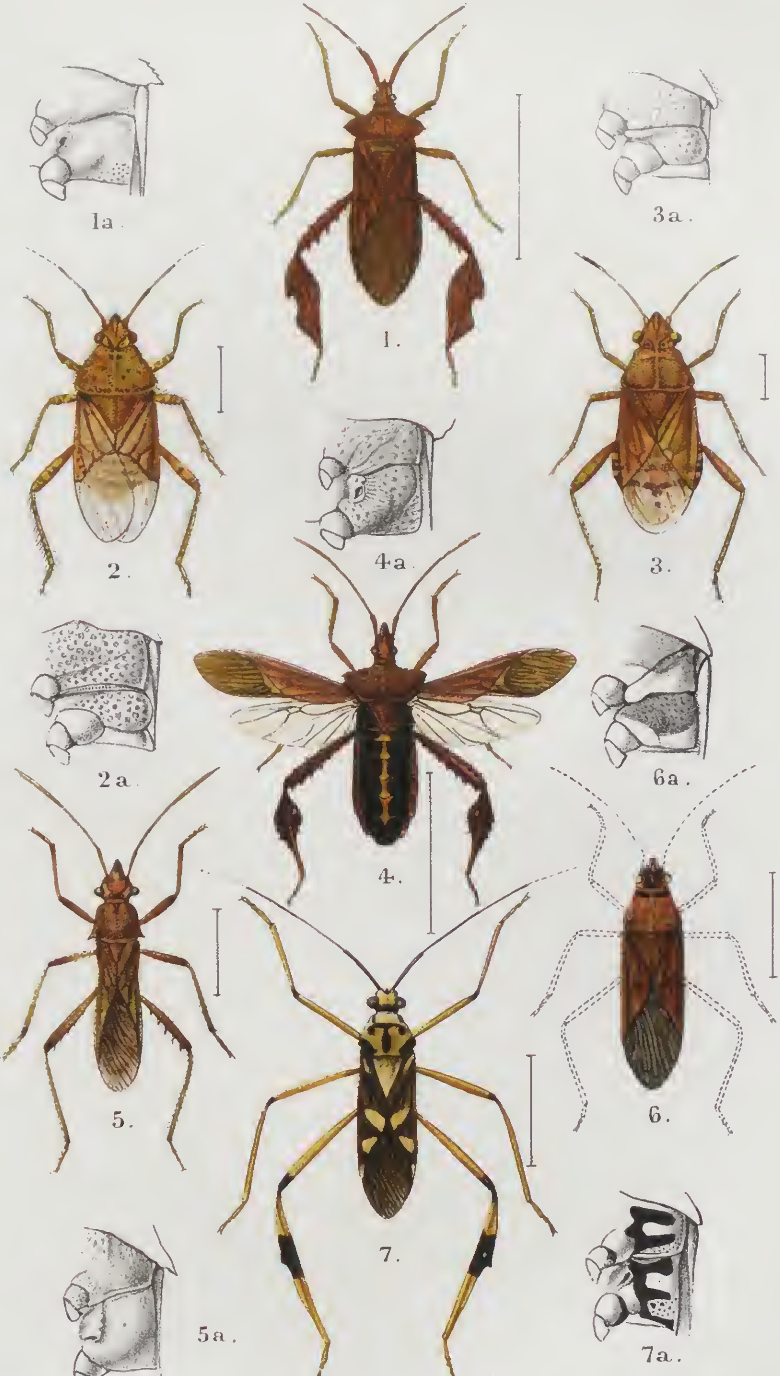
Species treated as Synonymic.

Spartocerus bimaculatus Westw. in Hope [Cat. ii. p. 7 (1842).	=*Sephina erythromelæna* [White.
,, *lateritius* Westw. l. c.	=*Spartocera fusca* Thunb.
,, *affinis* Westw. l. c.	= ,, ,,
,, *subfulvus* Westw. l. c. p. 8	= ,, *cinnamomea* [Hahn.
Physomerus affinis Westw. l. c. p. 9	=*Amorbus rubiginosus* Guér.
Myctis punctum Westw. l. c. p. 10	=*Anoplocnemis phasianus* [Fabr.
,, *affinis* Westw. l. c.	= ,, ,,
,, *bicolor* Westw. l. c.	= ,, ,,
,, *fasciatus* Westw. l. c. p. 11	=*Mictis tenebrosus* Fabr.
,, *parallelus* Westw. l. c. p. 12	=*Anoplocnemis pectoralis* [Germ.
,, *apicalis* Westw. l. c.	= ,, *curvipes* Fabr.
,, *horrificus* Westw. l. c.	= ,, *pectoralis* Germ.
,, *religiosus* Westw. l. c.	=*Cossutia flaveola* Dru.
,, *annulicornis* Westw. l. c. p. 13	=*Anoplocnemis westwoodi* [Dist.
,, *ventralis* Westw. l. c.	= ,, *fuscus* Westw.
Pachylis grossus Westw. l. c.	=*Pachylis laticornis* Fabr.
Nematopus ventralis Westw. l. c. p. 14	=*Nematopus nervosus* Lap.
Metapodius bispinus Westw. l. c. p. 15	=*Acanthocephala femorata* [Fabr.
,, *obscurus* Westw. l. c.	= ,, ,,
,, *nigricans* Westw. l. c.	= ,, *consobrina* [Westw.
,, *gemmifer* Westw. l. c. p. 16	=*Petalops azureus* Burm.
Anisoscelis fraterna Westw. l. c.	=*Leptoglossus phyllopus* [Linn.
,, *indocta* Westw. l. c.	= ,, *stigma* Herbst.



Horace Knight del. et lith. Mintern Bros Chromo

RHYNCHOTA OF THE FAMILY COREIDÆ.



Horace Knight del.et lith.

Mintern Bros. Chromo.

RHYNCHOTA OF THE FAMILY COREIDÆ.

Leptoscelis rubro-picta Westw. l. c. p. 17 = *Phthia lunata* Fabr., var.
Stenoscelidea bicoloripes Westw. l. c. [p. 18. = *Placoscelis fusca* Spin.
Leptocorisa bengalensis Westw. l. c. = *Leptocorisa acuta* Thunb.
,, *furcifera* Westw. l. c. = ,, *filiformis* Fabr.
,, *crudelis* Westw. l. c. = ,, *tipuloides* de Geer.
Alydus ichneumoniformis Westw. l. c. = *Hyalymenus dentatus* Fabr.
,, *diversipes* Westw. l. c. p. 19 = ,, *tarsatus* Fabr.
,, *affinis* Westw. l. c. = ,, ,,
,, *obscurus* Westw. l. c. = ,, ,,
,, *consorbrinus* Westw. l. c. p. 20 = *Megalotomus rufipes* [Westw.
,, *ventralis* Westw. l. c. = *Riptortus fuscus* Fabr.
,, *undulatus* Westw. l. c. = *Camptotus lateralis* Germ.
,, *albidens* Westw. l. c. = *Mirperus torridus* Westw.
Meropachus subluridus Westw. l. c. p. 21 = *Hirilcus gracilis* Burm.
,, *dorsiger* Westw. l. c. = ,, *variolosus* Burm.
Hypselonotus bilineatus Westw. l. c. = *Hypselonotus interruptus* [Hahn.
Crinocerus fuscus Westw. (part.) l. c. = *Acanthocoris scabrator* [Fabr.
,, ,, ,, (part.) l. c. = ,, *scaber* Linn.
Ceratopachys capensis Westw. l. c. p. 22 = *Homœocerus nigricornis* [Germ.
Coreus parvulus Westw. l. c. p. 23 = *Cletus capitulatus* H.-Schäff.
,, *immaculatus* Westw. l. c. = *Cletus ochraceus* H.-Schäff.
,, *alternans* Westw. l. c. p. 24 = *Homœocerus pallens* Fabr.
Neides trispinosus Westw. l. c. = *Jalysus spinosus* Say.
Gonocerus dorsiger Westw. l. c. p. 25 = *Catorhintha guttula* Fabr.
,, *angulatus* Westw. l. c. = *Sethenira testacea* Spin.
Arenocoris ? tibialis Westw. l. c. = *Ceraleptus gracilicornis* [H.-Schäff.
Pyrrhotes bicolor Westw. l. c. p. 26 = *Jadera sanguinolenta* Fabr.

TYPES MUTILATED AND THEREFORE OF DOUBTFUL POSITION.

Alydus simplex Westw. in Hope Cat. ii. p. 18 (1842).
,, *gracilipes* Westw. loc. cit. p. 20.

EXPLANATION OF THE PLATES.

PLATE XXIX.

Fig. 1. *Acanthocephala æqualis*, p. 329.
2. *Amorbus angustior*, p. 328.
3. *Anoplocnemis varicornis*, p. 327.
4. *Melania gracilis*, p. 326.
5. *Amorbus subserratus*, p. 328.
6. *Acanthocoris affinis*, p. 330.
7. *Acanthocephala consobrina*, p. 329.

PLATE XXX.

Fig. 1. *Empedocles tenuicornis*, p. 329.
2. *Corizus robustus*, p. 332.
3. —— *vincentii*, p. 332.
4. *Leptoglossus fulvicornis*, p. 330.
5. *Megalotomus parvus*, p. 331.
6. *Serinetha fraterna*, p. 332.
7. *Stenoscelidea albovaria*, p. 329.

[*From the* PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON, January 15, 1901.]

On some new and interesting Exotic Spiders collected by Messrs. G. A. K. Marshall and R. Shelford. By the Rev. OCTAVIUS PICKARD-CAMBRIDGE, M.A., F.R.S., &c.

(Plate V.[1])

Order ARANEIDEA.

Fam. DRASSIDÆ.

Gen. PROSTHESIMA L. Koch.

PROSTHESIMA ALBOMACULATA, sp. n. (Plate V. figs. 2–2 *c*.)

Adult female, length $2\frac{1}{3}$ lines (4·5 mm.).

Cephalothorax flattish, oval, truncate at each end, fore end rather the narrowest, lateral marginal impressions at caput very slight, profile-line nearly level. Colour deep black-brown, softening to yellowish brown round the thoracic indentation; surface thinly covered with grey adpressed hairs.

Eyes in two transverse rows of very nearly equal length. Curve of posterior row slight and its convexity directed backwards. Anterior row almost straight, laterals of this row largest of the eight, the two centrals being placed on a slight prominence, and further from each other than from the laterals. The two centrals of the posterior row are much further from each other than from the laterals and are slightly the largest. The four centrals form a quadrangle as long as broad, the fore side being shortest.

Legs moderate in length and strength, 4, 1, 2, 3. Colour yellow to yellow-brown; the tibiæ, femora, and genuæ of the first pair black-brown, these joints of the second pair yellow-brown, and of the third and fourth pairs more or less deeply marked longitudinally and suffused with black and brown, furnished with coarse hairs and spines, the latter most numerous and strongest on the tibiæ and metatarsi of the third and fourth pairs.

Falces, *maxillæ*, and *labium* deep brown.

Sternum oval, pointed behind; colour reddish yellow-brown.

Abdomen oval, somewhat flattened, black, with four conspicuous white spots forming a quadrangle on the fore half of the upperside, the two hinder spots largest and nearly round, the anterior, near the fore margin, oval or subtriangular and forming a shorter transverse line than the hinder spots. On each side of the underside, about the middle, is a large somewhat irregular triangular-shaped white patch, whose inner angles are nearly contiguous a little way behind the middle. Spinners of the inferior pair much wider apart than the superiors. Genital aperture simple but characteristic in form.

Hab. Salisbury, Mashonaland, S. Africa, 5000 feet, Nov. 1898 to Jan. 1899 (*G. A. K. Marshall*).

[1] For an explanation of the Plate, see p. 16.

Gen. nov. Titus.

Cephalothorax elongate-oval, rounded behind, broadly and a little roundly truncate before; lateral marginal impressions at the caput gradual but distinct; upper surface strongly convex; from the fore part of the caput to the hinder slope the rise is strong, a little curved and even, with a very slight dip at the thoracic junction. The sides of the cephalothorax project over the bases of the legs, making them appear to be articulated on the same plane as the sternum. The thoracic indentation is very minute, and the other normal ones obsolete; hinder slope steep; height of the clypeus, which projects, is half that of the facial space, its fore margin overhanging the base of the falces.

Eyes moderate and not greatly unequal in size; in two transverse curved rows; the hinder row considerably longest, its eyes are very nearly equally separated, and the convexity of its curve is directed forwards, while that of the anterior row is backwards. The hind-lateral eyes are larger than the hind-centrals and are placed outside a strong tubercle; those of the anterior row on a well-marked transverse prominence or ridge. The fore-centrals are very nearly if not quite of equal size, the interval between them being about double that which separates each from the fore-lateral eye on its side. The central quadrangle is slightly broader than long, and its anterior side shortest.

Legs short, rather slender, 4, 1, 2, 3; the femora strongly clavate or tumid at their posterior end, furnished with hairs and spines; two pairs of these are beneath the metatarsi and three pairs beneath tibiæ of the first pair. Tarsi end with 2 claws.

Palpi (♀). The digital joint is double the length of the radial, rather claviform, and ending with a very minute, slightly curved single claw.

Falces moderate in length, powerful, subconical.

Maxillæ rather short, strong, straight, but inclined to the labium; rounded at their outer extremity, and a little impressed and obliquely truncate at their inner extremity.

Labium short, broader than long, narrowest at the apex, the outer corners of which are rounded, and the middle a little impressed.

Sternum longer than broad, oval, slightly hollow-truncate in front, bluntish pointed behind, and its margins strongly indented by the basal joints of the legs. From the hinder end a chitinous plate runs between the coxæ of the fourth pair of legs and spreading out behind them joins in with the upperside of the cephalothorax.

Abdomen short, broad, its upper surface covered with a strong kind of granulose coriaceous shield furnished with plumose and other hairs; sides, especially backwards, protuberant and tumid, these parts connected behind by transverse rugæ or folds, in the midst of which the spinners are placed and almost hidden in a circular cavity.

Titus lugens, sp. n. (Plate V. figs. 3–3 *e*.)

Adult female, length $2\frac{1}{2}$ lines.

Cephalothorax bright red-brown, suffused with a darker hue on the sides and on the caput, the fore part of which is nearly black; the surface is thickly covered with small round shining tubercles or granulosities, and it is thinly clothed with hairs, of which some on the sides and hinder part are white and of a plumose nature.

Legs yellow tinged with brown; the femora much strongest, granulose, as also are the uppersides of coxæ. Colour of the femora of 1st pair black-brown, of the second pair not so dark, of the third and fourth pairs paler and indistinctly banded with darker. The tarsi are enlarged slightly and gradually to the ends, which are furnished with two claws and a compact claw-tuft.

Falces deep reddish black-brown, paler at the fore extremity, furnished in front with bristly hairs.

Maxillæ and *labium* yellow-brown.

Sternum yellow-red, covered thickly with small granulosities like the cephalothorax.

Abdomen coriaceous, covering of the upperside black with a central triangular patch of white plumose hairs, two patches of the same on the lateral margins, and one at the hinder extremity, sides and underside of a paler browner hue. The fore extremity on the underside is covered with a coriaceous granulose integument (the granulosities much strongest and becoming tubercular at the fore end), which forms a short sheath, covering most of the connecting pedicle as well as the spiracular openings and the genital aperture. For the peculiar form of the abdomen, see generic characters above; but whether this is only specific or whether generic, it is hard to say in the absence of allied species.

Hab. Salisbury, Mashonaland, S. Africa, 5000 feet, Nov. 1898 to Jan. 1899 (*G. A. K. Marshall*).

Fam. Epeiridæ.

Genus Nephilengys L. Koch.

Nephilengys malabarensis Walck.

An adult female of this common and widely dispersed Epeirid from Karkloof, Natal (*G. A. K. Marshall*).

Fam. Gasteracanthidæ.

Subfam. Eurycominæ.

Gen. Cyrtarachne Thor.

Cyrtarachne conica, sp. n. (Plate V. figs. 1–1 *c*.)

Adult female, length rather over $3\frac{1}{2}$ lines, or 8 mm.; length of abdomen $2\frac{1}{2}$ lines, width $3\frac{1}{3}$ lines.

Cephalothorax short, slightly longer than broad, broadest and

Falces rather shorter than the caput, strong, prominent, of a dull yellow-brown colour.

Maxillæ dull blackish, extremities pale yellowish.

Labium dull black, apex pale.

Sternum elongate, narrow; the basal joints of the legs are articulated around it on the same plane, the first two pairs with their coxæ almost contiguous on their inner sides.

Abdomen narrow, elongate-oval, strongly and broadly constricted towards the fore extremity; pedicle as long as the caput, two-jointed, the posterior joint longest and set in a circular cavity or socket at the extremity of the abdomen. Colour black, a little paler at the constricted part, just below the sides of the constriction white.

Hab. Singapore. Sent by Mr. H. N. Ridley to Mr. R. Shelford.

EXPLANATION OF PLATE V.

Fig. 1. *Cyrtarachne conica*, ♀ (p. 13). 1 *a*, profile; 1 *b*, eyes and falces from in front; 1 *c*, genital aperture.

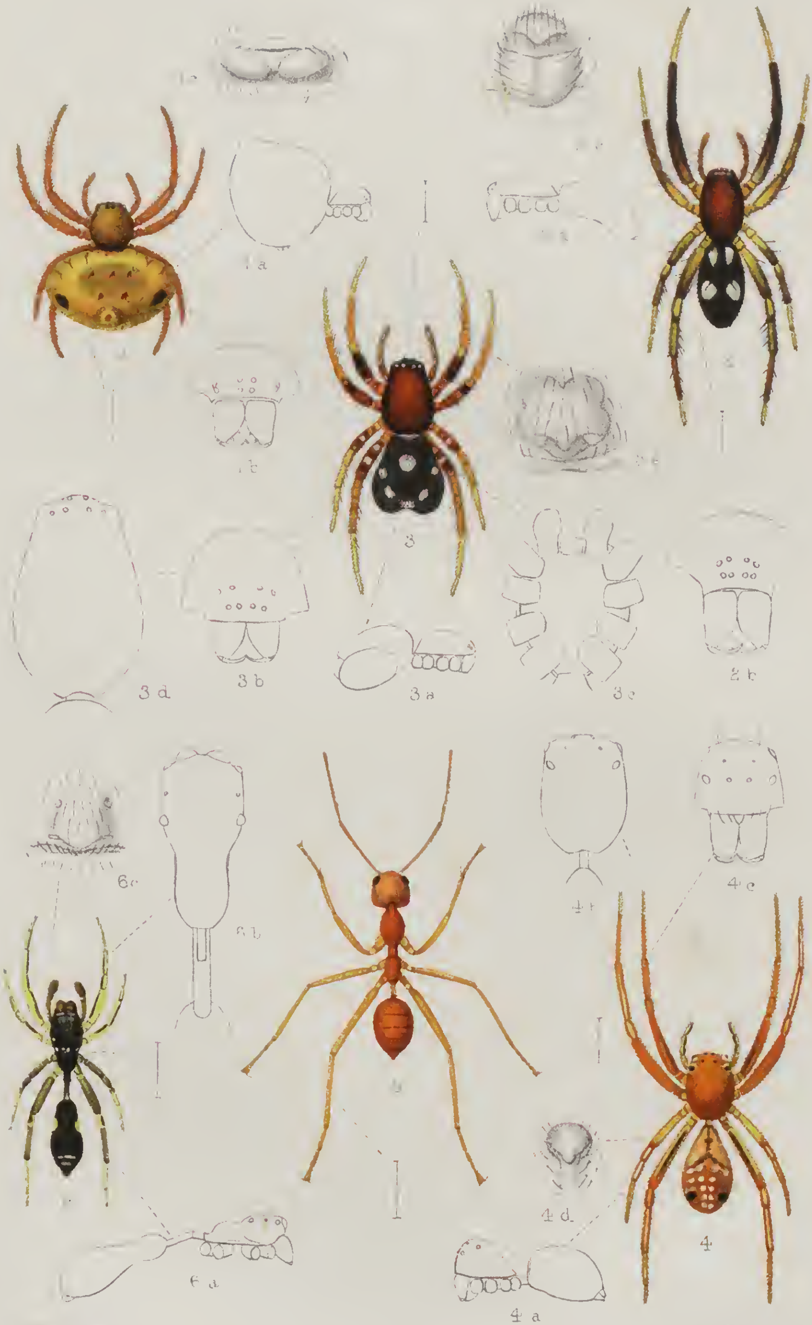
2. *Prosthesima albomaculata*, ♀ (p. 11). 2 *a*, profile; 2 *b*, eyes and falces from in front; 2 *c*, genital aperture.

3. *Titus lugens*, ♀ (p. 13). 3 *a*, profile; 3 *b*, eyes and falces from in front; 3 *c*, maxillæ, labium, and sternum; 3 *d*, cephalothorax and eyes from above and behind; 3 *e*, genital aperture.

4. *Amyciæa lineatipes*, ♀ (p. 14). 4 *a*, profile; 4 *b*, eyes and falces from in front; 4 *c*, eyes and cephalothorax from above and behind; 4 *d*, genital aperture.

5. *Œcophylla smaragdina* (p. 15). (Ant with which *Amyciæa lineatipes* lives.)

6. *Salticus attenuatus*, ♀ (p. 15). 6 *a*, profile; 6 *b*, cephalothorax and connecting pedicle from above; 6 *c*, genital aperture. (It is doubtful whether this example is quite adult.)



A.T. Hollick del. et lith.

West, Newman chromo.

NEW EXOTIC SPIDERS.

Reprinted from "*The Entomologist's Monthly Magazine,*" *Second Series, Vol.* xii.]

BALEARIC INSECTS.

INTRODUCTION, BY EDWARD B. POULTON, M.A., F.R.S.,
Hope Professor of Zoology in the University of Oxford,
Fellow of Jesus College, Oxford.

Having recently paid two visits to Majorca, the first in the spring of 1900, the second in the summer of the present year, I hope that the material obtained may be gradually worked out by specialists, and published. Thus a systematic beginning, at any rate, of the study of the little known insect fauna of Majorca will be undertaken. The results of a couple of days' collecting in Minorca, April 6th and 7th, 1900, are also included, together with material obtained later, in the summer of the same year, and kindly sent me by Señ. Mauricio Hernandez of Mahon. The insect fauna of Minorca is, however, comparatively well known, especially the *Coleoptera*, a very complete list having been published (Mahon, 1872) by the late Dr. D. Francisco Cardona of Mahon.

The island of Majorca is about 60 miles in greatest length by 40 in greatest breadth. From the zoological aspect it presents three types of country:—

(1) The level plains, which are cultivated with remarkable diligence, so that the indigenous and derived insect faunas are almost confined to the road-sides, the beds of streams, occasional gardens, the neighbourhood of irrigation tanks, and the very few fields in which wild flowers have been permitted to remain.

(2) The mountains, chiefly developed and loftiest along the straight N.W. coast of the island, but also rising from the plains in isolated ridges and rounded masses. Here too the slopes are terraced and cultivated with extraordinary care, but numerous flowers exist, especially in the neighbourhood of the corn fields, and woods of low trees are to be found in many places. The higher steeper slopes are largely made up of bare rock with a scanty vegetation. A coarse grass growing in tufts is fairly abundant on some of the slopes. Some of the hills are almost covered with the palmetto, affording very barren ground to the collector. Pigs and goats are fed where the ground is not cultivated, even on the steepest and rockiest hill-sides.

(3) The low marshy land lying along the N.E. coast, bordering a portion of the circumference of the bays of Alcudia and Pollensa. This is probably the richest collecting ground in the island, and it has been unfortunately very little worked. Mr. Oldfield Thomas and Mr. R. I. Pocock collected for a day at Albufera, near the Bay of Alcudia, in the spring of 1900, and found the insects more abundant

and varied than elsewhere. I collected in the smaller area, called the "Little Albufera," adjoining the Bay of Pollensa in 1900, and again on two occasions, with Mr. W. Holland and Mr. A. H. Hamm, in July of the present year. We much wished to collect systematically in the larger and more important tract visited by Mr. Thomas and Mr. Pocock, but the prevalence of malaria at Alcudia prevented us. Even at Pollensa, where there is a little malaria, we were regularly bitten by numbers of mosquitos every night (although, as Mr. Theobald informs me, the specimens we brought home were only *Culex pipiens*, L.), and finding that mosquito curtains were unknown at the Fondas in Alcudia, I decided that the risk was too great. Had I been aware of the conditions I should have arranged to take portable mosquito-proof coverings.

From the above account it will be clear that only a small proportion of the indigenous insect fauna can now be looked for in Majorca. Excessive cultivation, continued from a remote historic period, cannot fail to have destroyed by far the larger number of the species. At the same time there is reason to hope that the remainder will exhibit many features of interest.

Minorca is probably relatively much richer than Majorca. There is not that excessive devotion to agriculture which is so characteristic of Majorca, but grass is grown freely, and with it a varied and tolerably luxuriant vegetation. The surface of the island is much flatter and less interesting, the highest hill, Mount Toro, being only 1150 feet.

The first two sections, by Mr. Edward Saunders, contain an account of the *Hymenoptera Aculeata* and the *Hemiptera* collected in the spring of 1900 by Mr. Thomas and Mr. Pocock, and presented to the British Museum of Natural History, and those collected by me at the same time and presented to the Hope Department of the Oxford University Museum. The specimens described below may be seen in these two Institutions. I have added a few notes of locality, habits, &c. The third section, by Col. J. W. Yerbury, will contain an account of the *Diptera* collected by the same naturalists at the same times and places as the *Hymenoptera* and *Hemiptera*.

The following is an account of the route I followed in 1900.

March 24th, 25th and part of 26th—Palma. Collected at Porto Pi, and especially in the grounds of Bellver Castle (150 to 400 feet), where flowers were very abundant. This was the most favourable locality I met with during the visit in 1900. Weather fine and sunny.

March 26th and 27th—Valldemosa and Miramar. High ground

with mountains behind and sea in front; weather sunny. Collected (27th) by road-side from Miramar to Valldemosa, and in Arch-Duke's garden and the cliff below. Then drove to Soller.

March 28th and 29th—Soller. Excessively cultivated valley, surrounded by high mountains. Weather cold and cloudy, unsuitable for collecting. Returned to Palma on 29th.

March 30th—Bellver Castle in the morning (sunny): then to Manacor.

March 31st—Manacor, cloudy and cold: travelled to Pollensa, collecting in a field at Empalme on the way.

April 1st, 2nd, 3rd and 4th—Pollensa. Collected on low hills near the town (1st and 2nd), and on the way to the Castillo del Rey on the 3rd, the road rising to a considerable elevation as it approached the coast. These three days sunny and warm. On the 4th (cloudy) collected on the low ground and in the ditches by the Port of Pollensa. Left for Minorca at night.

April 5th, 6th and 7th—Mahon, Minorca. Hard rain on 5th. On the 6th and 7th collected at a low elevation near Mahon; very windy and cloudy (gleams of sun on the 6th).

Mr. Thomas and Mr. Pocock collected at Inca, Majorca (March 24th to April 2nd, 1900), a small town lying towards the centre of the island in the richly cultivated plain, but near to the N.W. chain of mountains. They collected insects chiefly on the hill-sides, near the water-tanks, and in the copses in the neighbourhood of the town, making one excursion to the Albufera near Alcudia, and another to the caves of Manacor.

In Minorca they collected at San Cristobal (April 6th to 15th, 1900), a small village lying from two to three miles distant from the southern coast of the island at an altitude of about 300 feet. The country round is given over to cultivation; but on the slopes of the deep limestone gullies that run from the village down to the sea, as well as on the sides of a rugged hill a mile or so to the north of the village, the soil has been left to a considerable extent undisturbed. Here and along the sides of the main road, where wild flowers, especially a species of clover, grew luxuriantly, most of the *Hymenoptera* were procured (see also P. Z. S., 1901, pp. 35, 36).

This account will make clear the captors of any of the specimens mentioned below, but it may be stated generally that when no name is given after the locality the capture was made by me.

Oxford: *July*, 1901.

Reprinted from "The Entomologist's Monthly Magazine," Second Series, Vol. xii.]

BALEARIC INSECTS.—*HYMENOPTERA ACULEATA*

COLLECTED IN MAJORCA AND MINORCA (MARCH AND APRIL, 1900) BY E. B. POULTON, OLDFIELD THOMAS, AND R. I. POCOCK, WITH DESCRIPTIONS OF NEW SPECIES.

BY EDWARD SAUNDERS, F.L.S., &c.

Camponotus Sicheli, Mayr, ☿, 2, Monte Sentuiri, near Pollensa, Majorca, April 2nd.

Lasius niger, Linn., ☿, 2, Pollensa, April 1st and 2nd.

Aphænogaster barbara, Linn., ☿, 11, Palma, Majorca, March 24th.——*testaceopilosa*, Linn., ☿, 9, Palma, Majorca, March 24th.

Mutilla quinquemaculata, Cyr., ♀, 1, near Mahon, Minorca, April 6th.

Elis ciliata, Fab., ♂, 26, ♀, 1. This species was excessively abundant in the grounds of Castle Bellver, Palma, Majorca, March 25th, 26th, and 30th. 'It was in this locality that the only female out of 39 individuals captured was secured (March 25th). Specimens were also obtained from the summit of the Puig de Maria, Pollensa, April 2nd, and from the summit of the Talayot of Trepuco, near Mahon, Minorca. The species was thus never seen except on hills and mounds. The insects flew close to the ground, continually alighting on the earth and stones, E. B. P.; 3 ♂, 1 ♀, not localised, Thomas and Pocock, 1900.

Pompilus viaticus, L., ♀, 5 (wings very dark), Castle Bellver, March 26th and 30th; below Castle del Rey, Pollensa, April 3rd; Monte Sentuiri, Pollensa, April 2nd.

Ammophila hirsuta, Scop., ♀, 9, Palma, March 24th; Bellver, March 25th, 26th, and 30th; Miramar, March 27th (Hernandez).

Pelopæus spirifex, L., ♂ ♀, Minorca.

Odynerus parietum, L., ♂, 2, Pollensa, Monte Sentuiri, and Puig de Maria, April 2nd; ♂, 2, Minorca, near Talayot of Trepuco, near Mahon, April 6th; ♂, Inca, Majorca, and San Cristobal, Minorca, March and April, 1900, Thomas and Pocock.——sp.?, ♂, 2. I should not like to name this for certain without seeing both sexes. Minorca, N. of Port Mahon, April 7th.

Polistes gallica, L., ♀, 5, Minorca, near Talayot of Trepuco, April 6th.——♀, 8, Majorca, Palma, Porto Pi, March 24th; Castle Bellver, March 25th and 30th; Miramar to Valldemosa, March 27th; Pollensa, April 2nd and 3rd (very abundant); Albufera and Inca, Majorca, March and April, Thomas and Pocock.

Prosopis, sp.?, ♂, closely allied to *Masoni*, Saund., but on a single example I cannot determine it for certain. Pollensa, Monte Sentuiri, April 2nd.

Sphecodes fuscipennis, Germ. (var. with red legs), 3 ♂, 3 ♀, Pollensa, base of Monte Sentuiri, April 2nd (on flowers); Castle Bellver, March 25th and 30th. ♂ and 2 ♀, not localised Thomas, and Pocock, 1900.

Halictus scabiosæ, Rossi, ♀, 6, Castle Bellver, March 25th and 30th; Miramar, March 27th (on flowers); ♀, Inca, Majorca, March, and 1 ♀ not localised, Thomas and Pocock, 1900.——*malachurus*, K., ♀, 1, Pollensa, Puig de Maria, April 2nd.——*villosulus*, K., ♀, 3, Castle Bellver, March 30th; Pollensa, Monte Sentuiri, April 2nd.——sp.?, ♀, 6, Castle Bellver, March 25th, 26th, and 30th; Pollensa, April 3rd.——*cephalicus*, Mor., ♀, 1, Pollensa, Puig de Maria, April 2nd.

Halictus soror, n. sp., ♀, 2, Castle Bellver, March 26th and 30th.

♀. *H. morioni*, affinis, obscure viridi-niger, capite thoraceque albopilosis opacis, creberrime punctatis, facie sat elongata, plus minus ut in *punctatissimo* formata, clypeo plus quam dimidio latitudinis sui ultra oculis projecto, abdominis segmentibus submicantibus, viridi-nigris crebre punctatis, apicibus, præsertim in lateribus, valde impressis, marginibus posticis piceis; pedibus nigris. Long., 6—7 mm., a *Morioni* differt facie valde elongata, corpore opaco, colore viridi-nigro non æneo-nigro crebriore punctato, præsertim in segmento basali abdominis.

♂. a *morioni* differt capite elongato, clypeo valde producto.

I have received both sexes of this species from Algeria, taken by Rev. A. E. Eaton, and I have made my remarks on the ♂ from one of his captures.

Andrena morio, Brullé, ♀, 4, Castle Bellver, March 30th; ♂ and ♀, Inca, Majorca, Thomas and Pocock, 1900.——*rosæ*, Pz. (r. *Trimmerana*), ♀, 1, Miramar, March 27th.——sp.?, ♀ (stylopized), Miramar, March 27th.——*Gwynana*, K., ♀, var.?, very obscure in coloration, Miramar, March 27th (on flowers).——*nigro-olivacea*, Dours, 8 ♂, 1 ♀. The males, Miramar, March 27th (on flowers); female, Pollensa, April 3rd. The males are of the ordinary type of this species, but the ♀ is peculiar in having the tibiæ black instead of testaceous.——*flavipes*, Pz., = *fulvicrus*, Kirb., ♂ 2, ♀ 6, Castle Bellver, March 25th and 30th; Pollensa, April 2nd.—— var.?, ♀, 1; not localised, Thomas and Pocock, 1900.——sp.?, group of *Afzeliella*, &c., ♀, 3, Castle Bellver, March 30th; Pollensa, April 2nd and 3rd.

Dioyxs cincta, Jur., ♀, 2, San Cristobal, Minorca, April 6th to 14th, 1900, Thomas and Pocock.

Nomada fucata, Pz., var. *iberica*, ♀, 1, not localised, Thomas and Pocock, 1900.

Nomada Poultoni (n. sp.), ♂ 1, ♀ 3, Castle Bellver, one female, March 25th, all others March 30th (on flowers), all were captured on the summit of the hill (400 ft.) outside the castle.

♂. Caput nigrum opacum, creberrime rugoso-punctatum ochraceo-fusco dense hirsutum, clypeo antice, faciei lateribus, macula minuta supra clypeum lineaque pone oculis, mandibulis (apicibus piceis exceptis), labroque flavis, hoc inermi; antennis fulvis, scapo, articulisque 3—9, supra plus minus nigris, flagelli articulis 2do 3tio que subæqualibus, 3tio, quarto, paullo longiore. Thorax niger, sculpturâ vestituque capiti simillimus, tegulis, callis humeralibus, maculaque pleurali sub tuberculis, maculisque duabus minutis scutellaribus flavis, alis subinfuscatis, nervis piceo-testaceis. Abdomen superne punctatissimum, fere ut in *fucata*, Pz. coloratum, segmento basali omnino læte ferrugineo, reliquis fascia integra, medio subconstricta, flava ornatis, 5, 6, 7, fere totis flavis; septimo apice emarginato; subtus testaceum, nitidum, segmento sexto valde punctato, ceteris fere impunctatis; pedibus fulvis, coxis, trochanteribus, femoribusque linea subtus nigra; tibiis posticis prope apicem unco uno munitis, metatarsorum lateribus subparallelis.

♀. Nigra, clypeo, macula supra clypeum, faciei lateribus, mandibulis (apicibus nigris exceptis) labro, antennis, linea pone oculis, tegulis, callis humeralibus, maculaque obscurâ antice pleurale sub callis, scutelli tuberculis, linea subscutelli, abdomine, pedibusque læte ferrugineis; abdominis segmento quarto basi transverse nigro maculato, capite et thorace obscuris valde et creberrime punctatis, pilis fusco-

nigris dense vestitis, alis saturate infuscatis; abdomine submicante subtilissime et creberrime punctato, tibiis posticis apicibus productis, uncis duobus incurvatis nigro-fuscis armatis. Long., 13—14 mm.

This fine species, which I have much pleasure in naming after its talented captor, is somewhat allied to *pœcilonota*, Perez, but is very different in the black pubescence of the head and thorax and the general coloration.

Xylocopa violacea, L., ♂, 1, Valldemosa, Majorca, March 27th.

Ceratina Dallatorreana, Friese, ♀, 1, Inca, Majorca, March, 1900, Thomas and Pocock.

Chalicodoma sicula, Rossi, ♂ 22, ♀ 15, Minorca, near Mahon, April 6th.——♂ 10, ♀ 15, Majorca, Porto Pi, March 24th; Castle Bellver, March 25th and 30th; Pollensa, April 2nd; between Pollensa and Castle del Rey, April 3rd; Miramar to Valldemosa, March 27th. In Majorca these insects were found in stony hilly country, frequently settling on the ground. They were extremely hard to catch. In Minorca, on the other hand, they were far more abundant and easily captured. The difference may have been due to the colder, more windy, weather in the latter island (E. B. P.). San Cristobal, Minorca, and Inca, Majorca, March and April, 1900, Thomas and Pocock.

Anthidium 7-dentatum, Latr., ♀, Castle Bellver, March 26th.

Osmia cornuta, Ltr., ♀, 1, Miramar, March 27th (on flowers).——♀, not localised, 1900, Thomas and Pocock.——*Latreillei*, ♂, 2, Castle Bellver, March 26th (on wall); Minorca, near Tálayot of Trepuco, April 6th.——*submicans*, Mor., ♀, near Talayot of Trepuco, Mahon, April 6th; San Cristobal, Minorca, April 6th to 14th, 1900, Thomas and Pocock.——*cœrulescens*, L., ♂, 2, San Cristobal, Minorca April 6th to 14th, 1900, Thomas and Pocock.

Eucera numida, Lep., ♀, 1, near Mahon, April 6th (M. Hernandez).——*nigrilabris*, Lep., ♀, 10, Palma, March 24th (on cruciferous flowers); Castle Bellver, March 25th and 30th.——*grisea*, Fab., ♀, 1, Minorca, near Talayot of Trepuco, April 6th; 2 ♂, 1 ♀, Inca, Majorca, Thomas and Pocock; 5 ♀, no locality, Thomas and Pocock.——♂ 14, ♀ 21, Porto Pi, March 24th; Castle Bellver, March 25th and 30th (on flowers).

Melecta luctuosa, Scop., ♂ 2, ♀ 1, Castle Bellver, March 25th; Miramar to Valldemosa, March 27th; Pollensa to Castle del Rey, April 3rd; Inca, Majorca, Thomas and Pocock, 1900.——*plurinotata*, Brullé, ♂ 1, Castle Bellver, March 23rd.

Podalirius quadrifasciatus, Villers, ♀ 5, Minorca, 1900 (Hernandez).——*pilipes*, F., ♂ 7, ♀ 23, Palma, March 24th; Castle Bellver, March 25th, 26th, and 30th; Miramar, March 27th; Valldemosa, March 27th (colonies flying round their nests in holes in walls); Pollensa, April 3rd and 4th, A very abundant species, always found on flowers except at Valldemosa. ♀ 1, not localised, Thomas and Pocock, 1900.——*nigrocinctus*, Lep., ♀ 2, Minorca, near Talayot of Trepuco, April 6th.——♂ 3, ♀ 11, Castle Bellver, March 25th, 26th, and 30th (abundant on flowers). ♀, Inca, Majorca, March, 1900, Thomas and Pocock.——*balearicus*, Friese, ♂ 1, ♀ 2, Castle Bellver, March 30th; Pollensa to Castle del Rey, April 3rd. 1 ♂, Thomas and Pocock, 1900.

Bombus terrestris, L., var. *ferrugineus*, Schmied., ♂, 14, ☿, 5, ♀ 1, Castle Bellver, March 25th, 26th, and 30th; Miramar, March 27th; Pollensa, Puig de Maria, April 2nd and 5th (abundant on flowers). All the specimens taken of *B. terrestris* were of this form, which differs from the type in having the hairs of the tibiæ fulvous; it occurs in S. W. France, Spain, and Portugal, but the specimens I have of this species from Algeria, are of the type form.

Apis mellifica, Linn., ☿, 33, abundant everywhere in Majorca, Minorca, Talayot of Trepuco, April 6th. 1 ☿, Thomas and Pocock, not localised, 1900.

Thus 48 species were obtained. The number captured in June and July of the present year will turn out to be far larger.

Woking: *July*, 1901.

Reprinted from "*The Entomologist's Monthly Magazine*," *Second Series, Vol.* xii.]

BALEARIC INSECTS.—*HEMIPTERA-HETEROPTERA*

COLLECTED IN MAJORCA AND MINORCA (MARCH AND APRIL, 1900) BY E. B. POULTON, OLDFIELD THOMAS, AND R. I. POCOCK.

BY EDWARD SAUNDERS, F.L.S., &c.

Solenosthedium lynceum, Fieb., 1 ♀, not localised, 1900 (Thomas and Pocock).

240 *Eurygaster nigrocucullata*, Goeze, 1 ♀, Palma, Majorca, March 24th, 1900 (Poulton).

Graphosoma lineatum, L., 1 ♂, not localised (Thomas and Pocock).

Brachypelta aterrima, Forst., 2 ♂, Pollensa, N. Majorica, under stones, April 1st, 1900 (Poulton); Mahon, Minorca, April, 1900 (Poulton).

Sehirus morio, L., 1 ♂, Mahon, Minorca, April 7th, 1900 (Poulton).

Stenocephalus agilis, Scop., 2 ♂, 2 ♀, Miramar Grounds, N. W. Majorca (Poulton), March 27th, 1900.——1 ♀, Inca, Majorca, March 24th, 1900 (Thomas and Pocock). All these are of the variety with the apical *half* of the posterior femora black.

Lygæus pandurus, Scop., Majorca. Many of both sexes taken in Miramar Grounds, March 27th, 1900; and outside Castle Bellver, elev. 400 ft., March 26th, 1900, all of the variety with milky-white unspotted membrane, like those from Algeria; five pairs captured *in cop.* in the latter locality (Poulton).——1 ♂, Inca, Majorca, March, 1900 (Thomas and Pocock).

Pyrrhocoris ægyptius, L., 2 ♂, 3 ♀, along road from Miramar to Valldemosa, N. W. Majorca, March 27th, 1900 (Poulton).——*apterus*, L., 1 ♂, Mahon, Minorca, April 6th; 1 ♀, Palma, Majorca, March 24th, 1900 (Poulton); ♂ ♀, Albufera, Majorca, April, 1900 (Thomas and Pocock).

Hydrometra stagnorum, Ltr., 1 ♂, 3 ♀, Soller, N. W. Majorca, March 29th, 1900 (Poulton); ♂ ♀, Inca, Majorca, March, 1900 (Thomas and Pocock).

Velia rivulorum, Fab., 2 ♂, 2 ♀ (macr.), 1 ♂ (brach.), and larval forms. ditch near Port of Pollensa, N. Majorca, April 4th, 1900 (Poulton); 1 ♂, 5 ♀, and larva, Inca, Majorca, March, 1900 (Thomas and Pocock).

Gerris najas, de G., 1 ♂ (macr.), Albufera, Majorca, April, 1900 (Thomas and Pocock).——*thoracica*, Schum., 1 ♂, Inca, Majorca, March, 1900 (Thomas and Pocock).

Ploiaria domestica, Scop., 1 ♂, Inca, Majorca, March, 1900 (Thomas and Pocock).

Pirates strepitans, Ramb., 1 ♀, Albufera, Majorca, April 15th, 1900 (Thomas and Pocock).

Lopus lineolatus, Brullé, 1 ♂, Palma, Majorca, outside Castle Bellver, March 25th, 1900 (Poulton).

Pachytomella Passerini, Cost., 2 ♂, 1 ♀, Mahon, Minorca, April 7th, 1900 (Poulton).

Pachyxyphus lineellus, Muls. and Rey, 1 ♂, Palma, Majorca, March 25th, 1900 (Poulton).

Naucoris conspersus, Stål, 2, Inca, Majorca, March, 1900, not localized (Thomas and Pocock).

Notonecta glauca, L., v. *maculata*, 5 and 2 larvæ, Mahon, Minorca, April, 1900 (Poulton); 7, Inca, Majorca, March, 1900 (Thomas and Pocock).

Anisops producta, Fieb., ♀, 5, Majorca, ditch, near Port of Pollensa, April, 1900 (Poulton).

As in the case of the *Aculeata*, a far larger number of species were obtained in June and July of the present year.

Woking: *July*, 1901.

BALEARIC INSECTS.—*DIPTERA*.

COLLECTED IN MAJORCA AND MINORCA (MARCH AND APRIL, 1900) BY

E. B. POULTON, OLDFIELD THOMAS, AND R. I. POCOCK.

BY COL. J. W. YERBURY, LATE R.A., F.Z.S., &c.

Reprinted from "The Entomologist's Monthly Magazine," Second Series, Vol. xii.]

The *Diptera* collected by Professor Poulton and Messrs. Thomas and Pocock are not of any particular interest, but are such as may be collected in any part of Europe; the most interesting species are *Phorantha subcoleoptrata* and *Bombylius pallens*.

Where the name of the island is omitted, Majorca is always to be understood; where a reference to the collector is omitted, Poulton is to be accepted. The names Thomas and Pocock are indicated by their initial letters.

BIBIONIDÆ.

Dilophus humeralis, Zett. ?, 2 ♀, Pollensa, slope of Puig de Maria.——*humeralis*,? Zett., April 2nd, 1900, 2 ♀, Miramar, garden of Hospideria, March 27th, 1900, in bad condition (gummed on card), and therefore difficult to determine.

Bibio Marci, L., ♂ and ♀, Pollensa, base of M. Sentuiri; 2 ♂ and 1 ♀. Miramar, garden of Hospideria, March 27th, 1900; 1 Palma, March 25th, 1900, outside Castle Bellver, 400 ft.——*sp. inc.*, 1 ♂, Pollensa, Puig de Maria, April 2nd, 1900, gummed on card.

CHIRONOMIDÆ.

Chironomus, sp. inc., Albufera, April 13th, 1900 (T. and P.), fragment.

CULICIDÆ.

Culex, sp. inc., 2 ♀ specimens, 1 near Maracor, Porto Cristo, March 31st, 1900; 1 Palma, near Porto Pi, March 24th, 1900, different species in bad condition.

TIPULIDÆ.

Pachyrhina maculosa, Meig., ♂ and ♀, *in coitu*, Pollensa, slopes of Monte Sentuiri, April 2nd, 1900; 1 ♂, Pollensa, April 2nd, 1900, slopes of Puig Maria; 1 ♂ and 2 ♀, Inca (T. and P.).

Asilidæ.

Dysmachus trigonus, Meig., Castle Bellver, 350 feet, March 26th, 1900, single specimen.

Bombylidæ.

Bombylius pallens, Meigen (Eur. Zweif. Ins., vol. ii, p. 214), ♂, Pollensa, slopes of Puig de Maria, April 2nd, 1900; Inca, March, 2 ♂ and 1 ♀ (T. and P.); originally described from Portugal.

Syrphidæ.

Melanostoma, sp. inc., ♀, Palma, March 24th, 1900.——*sp. inc.*, 2 ♀, Miramar grounds, March 27th, 1900, and Pollensa Road to Castillo del Rey, April 3rd, 1900 (these three specimens being all ♀ are difficult to identify, and in the absence of any guide for the identification of ♀ *Melanostoma* and *Platychirus*, even the genus of the specimen must be left in doubt).

Syrphus lasiopthalmus, Zett. ?, 2 immature ♀ specimens, San Cristobal, Minorca, April 10th, 1900 (T. and P.); Miramar grounds, March 27th, 1900.——*nitidicollis*, Meig., Inca (T. and P.); Pollensa, April 1st, 1900.

Catabomba pyrastri, L., ♀, outside Castle Bellver, 400 ft., March 26th, 1900.

Eristalis tenax, L., 7, Castle Bellver, 250—400 ft., March 25th, 1900; 2, outside Castle Bellver, 400 ft., March 26th, 1900; 1, Miramar grounds, March 27th, 1900.——*æneus*, Scop., 4 ♂, Miramar grounds, May 27th, 1900.

Myiatropa florea, L., Inca, Majorca, March, 1900 (T. and P.).

Syritta pipiens, L., ♀, Inca, Majorca (T. and P.), ♂ Pollensa, base of Monte Sentuiri, April 2nd, 1900; ♂, San Cristobal, Minorca, April 10th, 1900 (T. and P.), the last specimen seems aberrant; the hind femora being without any light marking. It is, however, carded, and is moreover in such bad condition that it is impossible to state definitely the species to which it belongs.

Chrysochlamys cuprea, Scop., Miramar grounds, Majorca, March 27th, 1900, a single very dark specimen of the var. *nigricornis*.

Chrysotoxum intermedium, Meig., ♀, 1, outside Castle Bellver, 400 ft., March 30th, 1900; ♂, Pollensa, Monte Sentuiri, April 2nd, 1900.

Conopidæ.

Zodion cinereum, F., outside Castle Bellver, 400 ft., March 30th, 1900.

Myopa dorsalis, F., outside Castle Bellver, 400 ft., March 26th, 1900, Mahon, Minorca, near Talyot of Trepuco, April 6th, 1900.

Muscidæ. (Tachininæ.)

Allophora (*Phorantha*) *subcoleoptrata* ?, single specimen, Miramar grounds, March 27th, 1900.

Pelleteria tesselata, F., 2, grounds, Castle Bellver, 300-400 ft., March 30th, 1900.

(Dexinæ.)

Nyctia halterata, Pz., 1, outside Castle Bellver, 400 ft., March 30th, 1900.

(Sarcophaginæ.)

Sarcophaga vulnerata, Schin., 1 ♂, Palma, March 24th, 1900, 1 ♀, Miramar grounds, March 27th, 1900; ♀, Inca, March, 1900 (T. and P.).——*albiceps*, Meig., 2 ♂, in Castle Bellver grounds, 250—400 ft., March 25th, 1, outside Castle, 400 ft., March 26th.——*hæmorrhoa* ?, Minorca, Mahon, April 6th, 1900, near T. of Trepuco.

The *Sarcophaginæ* are a family which requires the services of an expert for correct identification. The above should therefore be taken with caution.

Cynomyia sepulchralis, Meig., Singleton, ♂, outside Castle Bellver, 400 ft., March 30th, 1900.

(Muscinæ.)

Calliphora erythrocephala, Meig., 4, Pollensa, April 1st; 2, Miramar grounds, March 27th, and 1, Palma, March 24th.——*vomitoria*, L., 3 specimens, Pollenza, April 1st, 1900.

Musca corvina, F., near Manacor, Porto Cristo, March 31st, 1900, 1 spec. ——*domestica*, L., Palma, March 24th, 1900, three specimens.

Idia lunata, F., 1 ♀ outside Castle Bellver, 400 ft., March 30th, 1900.

Graphomyia maculata, Scop., 4 ♂, Pollensa, base of Monte Sentuiri, April 4th, 1900.

Cyrtoneura stabulans. Fall. ?, San Cristobal, Minorca, April 10th, 1900 (T. and P.), single specimen; spoilt by grease and therefore difficult to identify with certainty. Although the nomenclature adopted by Brauer and Bergenstann has been followed, still for the sake of convenience the species have been located in the old sub-families.

Anthomyidæ.

Hyetedosia scutellaris, Fall., Soller, March 29th, 1900.——*semicinerea*, Wied. ?, 2, Manacor, Porto Cristo, March 31st, 1900; 1, Soller, Biniarach, March 28th, 1900; 1, Miramar grounds, March 27th, 1900.

Ophyra anthrax, Meig., 1 ♀, Majorca, Pollensa, slopes of Puig de Maria, April 2nd, 1900; 2 ♀, Minorca, San Cristobal, April 10th, 1900 (T. and P.).

Spilogaster ?, sp. inc, near *depuncta*, Fall., Inca, March 24th, 1900 (T. and P.), headless.

Pegomyia, sp. inc., 2 ♀, Manacor, Porto Cristo, March 31st, 1900, carded, and therefore difficult to identify.

Caricea tigrina, F., ♂, Albufera, Majorca, April 15th, 1900 (T. and P.).

Fucomyia, sp. inc., Palma, March 24th, 1900, following Becker; this genus has been placed among the *Anthomyidæ*.

Cordyluridæ.

Scatophaga stercoraria, L., Inca, March, 1900 (T. and P.).

Trypetidæ.

Acidia heraclei, L., Miramar grounds, March 27th, 1900.

Sepsidæ.

Sepsis, sp. inc., probably *cynipsea*, Linn., Majorca, Sollen, March 29th, 1900; 3, Minorca, Mahon, near T. of Trepuco, April 6th, 1900; 4 gummed specimens, difficult to identify.

Piophila, sp. inc., 1, outside Castle Bellver, 400 ft., March 30th, 1900, gummed.

Borboridæ.

Limosina, sp. inc., Minorca, Mahon, 1 near T. of Trepuco, April 6th, 1900; 1, Palma, March 24th; 1, Pollensa, Ap. 4.

Three gummed fragments of different families quite undecypherable.

St. James's, S.W.:

October, 1901.

A NEW SPECIES OF *LYCÆNID* FROM UGANDA AND LAKE VICTORIA NYANZA.

BY S. A. NEAVE, B.A.

Reprinted from "The Entomologist's Monthly Magazine," Second Series, Vol. xiv.

PENTILA CLARENSIS, *n. sp.*

(Type ♂ from Toro Uganda, in the Hope Collection, Oxford University Museum).

Allied on the one hand to *P. amenaida*, Hew., and *P. mombasæ*, Grose-Smith, and on the other to *P. pauli*, Staud., the affinity to the latter species being the more pronounced. ♂. Expanse, 38·5 mm.

Upper-side: pale fulvous orange, with a few black spots. Hind margins of both wings bordered with dull black. This border is smooth across the apex of the fore-wing but serrated elsewhere. There is also a narrow black border along the costa of the fore-wing. In both wings a terminal discocellular spot.

The *fore-wing* has three sub-costal black spots immediately above the upper border of the cell. Below the cell is a larger spot between the 1st and 2nd median nervules. There are no spots within the cell Along the hind marginal border is a small discal row of two, or sometimes three minute spots. These are evanescent in the specimen from Nyangori.

The *hind-wing* has two spots on the costal margin, which may or may not be somewhat evanescent. Running parallel with the black hind margin is a discal row of small spots, usually five in number, of which the one nearest the costa is
137 much the largest. With the exception of the latter, these spots are evanescent in the specimen from Nyangori, in which however distinct traces of the corresponding spots upon the under surface of the wing are visible.

Under-side: paler than the upper-side; the whole of the hind-wing and the costa, apex and hind margin of the fore-wing being a dull buff. The rest of the fore-wing is of the same colour as the upper-side. The black border of both wings is absent, but there is a narrow black marginal line inside the black fringe. The fringe is interrupted opposite the internervular spaces by the spreading outwards of the ground colour. In the fore-wing these buff sections of the fringe are smaller than in the hind-wing where they may be much larger than the black sections. Within the fringe the narrow black line is thickened opposite the black sections, interrupted opposite the buff. A series of internervular black more or less linear markings occupies a submarginal position. In the hind-wings these markings are oval or moniliform spots; in the fore-wing they become more and more linear towards the apical angle. The spot nearest the inner margin of the fore-wing is especially

rounded in one specimen from Toro and of exceptionally large size, recalling the appearance in *P. amenaida var. nyassana*, Auriv. Each inwardly directed angle of the serrated margin on the upper-side coincides with the position of one of these marks on the under-side, as can be easily seen when the specimen is held to the light.

All the spots upon the upper surface are represented by corresponding ones (which are generally better marked) on the under-surface. This is especially the case in the discal rows of spots on both wings. That on the fore-wing comprises six spots, two of them being in the apical region, and that on the hind seven similar spots.

Additional marks on the under-surface are, in the fore-wing, a fourth distally placed subcostal spot, and in the hind-wing three large spots, placed just beyond the posterior margin of the discoidal cell.

In the reduction of the number of spots and in the sub-marginal streaks on the under-surface, *P. clarensis* exhibits an approach to *P. pauli*, Staud., but the reduction in the number of spots is not carried to the same extent, nor are the submarginal marks on the under-surface so linear in form as in that species. It is also interesting to note that in some specimens of *P. tropicalis*, Boisd., there is a feeble representation of the same serrated border to the hind-margin of the fore-wing which occurs in *P. clarensis*.

There can be but little doubt that *P. clarensis* provides an instance of Müllerian association with the very plentiful and widely distributed *Pardopsis punctatissima*, Boisd., to which it bears a marked general resemblance.

Three specimens of this *Lycænid*, all ♂'s, have recently been presented to the Hope Collection by Mr. Clare Aveling Wiggins, of Kisumu, after whom the species has been named. Two of them were collected by natives for Major Rattray in the Toro district in
Western Uganda, in November and December, 1900, and presented by 138
him to Mr. Wiggins. The third specimen was captured by Mr. Wiggins himself at Nyangori, near the east shore of the Victoria Nyanza, November 1—8, 1902. Mr. Wiggins is a most ardent Entomologist, and has, within the last six months, sent several thousand specimens of *Lepidoptera* from this district to the Hope department.

In conclusion, I should like to express my thanks to Mr. H. H. Druce for his kindness in giving his opinion upon this species.

Magdalen College, Oxford :
May, 1903.

Report of the Hope Professor of Zoology, 1902.

Many fine additions to the Hope Collections were made in 1902, but the following record must necessarily be incomplete because of the salutary change which has taken place in the date of appearance. The Report for 1901 appeared in June of last year and contained an account of the work which was done up to a few days before publication. It follows that, as regards labour spent in preparing, labelling, cataloguing, and incorporating the specimens presented during 1902, the present Report can only contain the complete records of about three quarters of a year.

The most important accessions during the year have been the great series of South African insects of many orders, and especially the bionomic material presented by Guy A. K. Marshall, Esq.; the fine collection of butterflies from Toro, Uganda, Lake Victoria Nyanza, and Mombasa, presented by C. A. Wiggins, Esq.; the South African Hymenoptera Aculeata, by Dr. F. N. Brown; the Oriental Heterocera, by Colonel C. Swinhoe; and the insects of many orders from Central Spain, by the Professor. Important donations have also been received from C. J. M. Gordon, Esq. (Southern Nigeria), Herbert Druce, Esq., F.L.S. (many localities), Lieut.-Colonel J. W. Yerbury (many localities), E. L. Meyer, Esq. (North Germany), W. J. Kaye, Esq. (British Guiana), W. L. S. Loat, Esq. (Blue Nile, Soudan, and North Uganda), F. A. Bellamy, Esq. (Tenerife), W. R. Allen, Esq. (North America), Hamilton H. Druce, Esq. (Russia).

The most important accessions to the British Collections have been due to the kindness of Lieut.-Col. J. W. Yerbury, Horace S. J. Donisthorpe, Esq., Professor T. Hudson-Beare, Major R. B. Robertson, W. C. Boyd, Esq., W. J. Lucas, Esq., Mr. W. Holland, and Mr. A. H. Hamm.

Valuable gifts to the Hope Library were made by a large

number of donors. A detailed account appears as the concluding section of this Report. The works presented by F. D. Godman, Esq., Hon. D.C.L., F.R.S., and the Hon. Walter Rothschild are of exceptional importance.

The work of the Department has suffered considerably from ill-health, Mr. Holland having been kept away for many weeks in the autumn as the result of an accident, and both he and Mr. Hamm having had influenza in the early part of 1903. In spite of these difficulties a great deal has been accomplished. Mr. Holland has finished the final arrangement of the great sub-family of the *Nymphalinae*, which has occupied him so long and absorbed so much of the space in the new cabinets. Seven cabinets with sixty drawers each contain the species of this group. This work finished, the arrangement of the remaining groups of the Rhopalocera is being rapidly completed, the chief difficulty being the want of cabinet accommodation. The *Heliconinae* have been arranged with ample space for addition for many years to come in forty drawers; and the *Acraeinae*, the last Nymphalid sub-family, are now being transferred to another series of forty drawers which are all that remain unoccupied of the last consignment of ten 20-drawer cabinets purchased for the Department. When this work is finished, as it must be in a few days, the necessity for more cabinet space will become pressing—and all the more so because six months must elapse before another order can be completed. The important sub-family of the *Papilioninae* has been worked out and arranged in temporary quarters in the old cabinets. The *Lycaenidae*, with the exception of the South American Theclas, have also been provisionally placed in an old cabinet with very small and too shallow drawers.

One chief piece of work rendered necessary by recent accessions has been the labelling of the vast collection of many thousands of Bornean insects of various orders presented in 1899, 1900, and 1901, by R. Shelford, Esq., M.A. This great demand upon the time of the Assistants has now nearly been met. Another task of perhaps greater magnitude has been the pinning, setting, and labelling of the large collection made

in Majorca and Spain (1901) by the Professor, Mr. Holland and Mr. Hamm. This too is now nearly complete. Mr. Hamm's time was also much occupied in preparing cabinet drawers, mounting specimens, and labelling for Colonel Yerbury's invaluable work upon our collection of Diptera, and also in specially preparing specimens to be photographed for the plates accompanying memoirs which have been written in the Department during the year. Other pieces of work are sufficiently indicated in the record of catalogued accessions which is given on pp. 20–22. Among these I must specially allude to the large amount of work which has been expended upon the valuable collection of British Coleoptera presented by Horace S. J. Donisthorpe, Esq. Precise data accompany all the specimens, but each form of label only applies to comparatively few, so that in printing, the type required to be altered hundreds of times for date or locality or both. The resetting of the old collection has unfortunately been entirely at a standstill during the year.

Dr. Dixey has now arranged the whole of the *Pierinae* in five 60-drawer cabinets. The work must not, however, be regarded as complete save for the incorporation of new material as it is received, for Dr. Dixey has set so high a standard in this part of our collection that considerable time must still elapse before the labour on the existing specimens is finished. It must be still many months before the instructive maps, which show at a glance the distribution of genera and species, will have been coloured and fixed in their places. The determination of the boundaries of the area of distribution of each species and genus involves prolonged and patient inquiry, and yet the result when expressed in colour on a map can be comprehended almost at a glance.

Colonel Swinhoe completed the arrangement of the Pyrales just before leaving Oxford. I take the opportunity of again saying that the warm thanks of the University are due to him for all that he has done for the Hope Collection of moths, during the many years of his residence in Oxford, and for the large number of specimens which he has added to the collection.

Early in the year Colonel J. W. Yerbury most kindly worked out by far the larger part of our general collection of Asilid flies and those of the British collection, residing in Oxford during some weeks for this purpose. That part of our collection has been rescued by his kind help from a condition of chaos, and it is now one of the best worked out and best arranged sections of the more difficult orders of insects. It is greatly to be desired that Colonel Yerbury may be able to renew his kind assistance.

At the end of 1902 and beginning of the present year, Mr. W. J. Lucas kindly undertook the naming and arrangement of our collection of British dragon-flies (Odonata). The British collections are a very important section of the Department, and it is most satisfactory to know that another group has now been brought into a condition of great practical utility.

Much kind help has also been afforded by naturalists to whom specimens from the Hope Collection have been carried or sent.

Mr. Hamilton H. C. J. Druce completed the working out of our *Lycaenidae*, and the specimens have now been brought back to Oxford. It is hoped that this last part of the family, including the American Theclas, will soon be arranged in the cabinet which contains the species previously named by the same distinguished authority on the group. The warmest thanks of the University are due to Mr. Druce for his great kindness, which has brought ordered arrangement and trustworthy determination into a difficult part of the collection, where there was so much confusion as to render it useless for all practical purposes.

The fine collection of Hymenoptera Aculeata made in Greece by the late Sir S. S. Saunders is being gradually worked out by his cousin Mr. Edward Saunders, F.R.S., who has always helped the Hope Department with the utmost kindness. When the work is finished it will constitute a memorable addition to our knowledge of the Mediterranean insect fauna.

The Professor took the opportunity afforded by a visit to Spain in July of last year to convey a large collection

of unnamed South African Orthoptera, presented to the Department by Mr. Guy A. K. Marshall, to Señor Don Ignacio Bolivar of Madrid, the eminent authority on this order of insects, who with the utmost kindness put aside other work and determined the great majority of the species in about ten days, so that they could be brought back to Oxford by hand on the return journey. One new genus and several new species were found in the collection. Don Ignacio also kindly presented to the Department a most valuable collection of named Spanish Orthoptera and insects of different orders from tropical West Africa.

Very kind help has been afforded to the Department by Monsieur Jules Bourgeois of Ste. Marie aux Mines, Alsace, the distinguished authority upon the Malacoderm Coleoptera, to whom numerous specimens of this group from Borneo and South Africa have been sent for identification. Many new species have been found by M. Bourgeois in the material sent, and these are being or have been described by him as *Lycocerus mimicus*, *Lycus marshalli*, *L. podagricus*, *L. conformis*, *L. poultoni*, *Lygistopterus barkeri*, and *Cladophorus natalensis*. In returning the boxes of identified specimens M. Bourgeois also kindly included specimens from his own collection presented to the Department.

A typical collection of *Brenthidae*, presented by Mr. R. Shelford, was very kindly worked out for the Department by the distinguished coleopterist Dr. A. Senna, of Florence, who determined and described the following new species in our series, *Diurus shelfordi*, *D. silvanus* (female, the male having been previously described), and *D. poultoni*.

In the Transactions of the Entomological Society for 1902 (pp. 541–9), many new species in the Hope Collection are described: a unique example of a splendid new Asilid fly, *Hyperechia marshalli*, described by Mr. E. E. Austen; a new genus, *Megapetus*, and four new species of Hemiptera by Mr. W. L. Distant; four new Hymenoptera by Col. C. T. Bingham; a very interesting and unique example of a carabid beetle, *Polyhirma bennettii*, by Mr. Guy A. K. Marshall; and the Telephorid, *Lycocerus mimicus*, alluded to above, by

Monsieur Jules Bourgeois. All these specimens are South African and, with the exception of the carabid, were captured and presented by Mr. Guy Marshall. *Polyhirma bennettii* was captured at Somerset West, Cape Colony, in Jan. 1900, by Mr. E. N. Bennett, M.A., Hertford College.

A few Hispidae were kindly named by Dr. Gestro, of Genoa, and one new species was found in the little Bornean collection which was sent to him.

Six members of the Council of the Entomological Society were able to accept the invitation for the first Saturday to Monday in July. There were present on July 5 to 7 the Treasurer, Mr. R. McLachlan, F.R.S.; one Secretary, Mr. H. Rowland Brown, M.A., University College; two Vice-Presidents, Dr. David Sharp, F.R.S., and the Professor; Rev. F. D. Morice, M.A., Queen's College; Mr. Arthur J. Chitty, M.A., Balliol College; and Col. C. Swinhoe, Hon. M.A., Wadham College; together with the following entomologists, Professor R. Meldola, F.R.S., Mr. H. S. J. Donisthorpe, Mr. Hamilton H. Druce, Mr. M. Jacoby, and Mr. Guy A. K. Marshall. I have to thank many friends, and especially the Vice-Chancellor, the Proctors, and Dr. F. A. Dixey, for their kind help in promoting the success of a visit which is of inestimable value to the Department.

An unusual number of African naturalists have been in England during the year 1902, and the Department has been visited by many kind friends who have presented specimens and sent notes and observations from various parts of the continent. Mr. Guy A. K. Marshall (Rhodesia) came many times and worked out our collection of the Rhynchophorous coleopterous genus, *Hipporrhinus*, of which he is making a special study, and the collections have also been seen by Mr. Horace A. Byatt, B.A., Lincoln College (Central African Protectorate), Mr. C. J. M. Gordon, B.A., Balliol College (Southern Nigeria), Mr. S. L. Hinde (East African Protectorate), and Mr. W. L. S. Loat (Soudan and N. Uganda).

Other kind friends of the Department have inspected some part of the collections at various times during the year:—

Mrs. W. B. Pryer, Mr. W. C. Boyd, Dr. Karl Jordan, Dr. Francis Jenkinson, Hon. D.Litt., and Dr. H. J. Hansen of Copenhagen, who brought back some types which had been lent him for study. Prof. G. B. Howes, F.R.S., Prof. James W. H. Trail, F.R.S., Prof. Charles S. Minot, Hon. D.Sc. of Harvard University, Prof. Arthur Dendy of The South African College, Cape Colony, and Dr. G. R. Parkin of Toronto, have also visited the Department.

As regards the publication of researches, the year 1902 has been by far the most fruitful of any in the last decade. This is mainly due to the fact that the work of many previous years reached its culmination in the appearance of a memoir on the "Bionomics of South African Insects," by Mr. Guy A. K. Marshall and the Professor (Trans. Ent. Soc. Lond., 1902, pp. 287–584, Plates IX–XXIII). The final arrangement of the manuscript of this publication was greatly helped by the presence of Mr. Marshall in England during the last summer, and his visits to Oxford. The chief part of Dr. Dixey's paper on "Seasonal Dimorphism in Butterflies" (Trans. Ent. Soc. Lond., 1902, pp. 189–218, Plate IV) also dealt with Mr. Marshall's experiments and observations in South Africa in the years 1896–1901. A third paper by Mr. S. L. Hinde on "The Protective Resemblance to Flowers borne by an African Homopterous Insect" (Trans. Ent. Soc. Lond., 1902, pp. 695–698, Plates XXVI, XXVII), contained further observations on the interesting "cluster of insects grouped to resemble a flower spike," figured by Professor J. W. Gregory, in the "Great Rift Valley" (London, 1896), and in some respects corrected the conclusions of this naturalist. The plates are of the highest importance, being reproductions in "three-colour" and half-tone, respectively, of sketches of the perfect insects and the larvae in their natural surroundings made upon the spot by Mrs. Hinde. In this, as in the other memoirs, the described material is deposited in the University Collections, and the authors, when non-resident, have been in continual communication with the Department. These three publications have been issued as the third volume of "Hope Reports," which has just appeared. Inasmuch as these

papers, dealing almost exclusively with African natural history, were amply sufficient to make up a volume, it appeared convenient to withhold a number of earlier publications concerned with material from other parts of the world. It is consequently anticipated that Vol. IV will be issued at no distant date, perhaps towards the end of the present year.

It was much hoped that another important memoir on the bionomics of Bornean Insects by Mr. R. Shelford, M.A., Curator of the Sarawak Museum at Kuching, Borneo, would have appeared in 1902, but there was some difficulty in the production of the five coloured plates. The paper will be published in the Proceedings of the Zoological Society in April next.

In the preparation of all these publications written in the Department, or by naturalists in various parts of the world in constant communication with the Department, the kindest assistance has always been received from Sir George Hampson and the whole staff of the Insect Department of the British Museum of Natural History. I particularly wish to thank Mr. C. O. Waterhouse, Mr. C. J. Gahan, Mr. G. J. Arrow, Mr. F. A. Heron, Mr. E. E. Austen, and Mr. R. I. Pocock (of the Arachnid Department), from all of whom I have received constant help. The following naturalists working in the British Museum have also rendered the kindest assistance, Colonel C. T. Bingham in the Hymenoptera, Colonel J. W. Yerbury in the Diptera, and Mr. W. L. Distant in the Hemiptera. All three naturalists contributed important sections to Mr. Marshall's memoir. I also desire to acknowledge the kind assistance of Mr. M. Jacoby, the Rev. H. S. Gorham and Dr. Karl Jordan.

The measure of success in research achieved during the past year by the Department is above all due to the efficient help of my assistants, Mr. W. Holland and Mr. A. H. Hamm, who have taken the keenest interest in the progress of the work, to Dr. F. A. Dixey in Oxford, and to Mr. Guy Marshall both in South Africa and in England.

Of the plates which illustrated the publications of the year

1902, no less than fourteen were reproduced from admirable photographs of the actual specimens taken by Mr. Alfred Robinson in the University Museum.

Additions to the Collection in 1898.

A set of 37 butterflies and 1 fine Elaterid beetle, from Sarawak, Borneo (unknown date), presented by Dr. F. A. Dixey, M.A., D.M., Fellow of Wadham College, have now been incorporated. The series includes Euploeine butterflies and their Papilionine mimics, an interesting addition to the bionomic collection.

Additions to the Collection in 1900.

Since the last Report a great deal of work has been expended upon the splendid series of Bornean insects presented by R. Shelford, Esq., M.A., but it has only been possible to catalogue a small proportion of the accessions of the year 1900.

An interesting set of 47 insects (Lepidoptera, Hymenoptera, Hemiptera, Neuroptera), 39 from various localities in the Faroë Islands, and 8 from Iceland (1900), were presented by the captor, N. Annandale, Esq., B.A., Balliol College. A fine series of 11 males and 4 females of *Hepialis humuli* (the English "Ghost Swift") compare in an interesting manner with the form *hethlandica* of the same species, from the Shetlands.

Forty-five insects of various orders from Port Elizabeth, South Africa, were presented by Malcolm Burr, Esq., B.A., New College, together with 34 Orthoptera from various localities (S.E. Europe, Ceylon, N. and S. America, and Madagascar), and 3 *Phryganidae* (Neuroptera) from Deal (1897) for the British Collection.

The remaining donations provisionally acknowledged in previous Reports are still uncatalogued, although it is hoped that this work may be completed during the present year.

Additions to the Collections in 1901.

The specimens presented in 1901 and provisionally acknowledged in the Report of last year are, with few exceptions, still uncatalogued; but an immense amount of time and labour have been expended upon the two chief donations, the specimens from Majorca and Spain presented by the Professor, Mr. Holland and Mr. Hamm, and those from Borneo presented by R. Shelford, Esq., M.A. The following have been catalogued and incorporated:

A specimen of *Sphinx convolvuli* captured (July 1900) on a steamer between Hull and Bergen and presented by Col. Swinhoe, together with 2 moths taken by him in Norway (1900).

Three Lepidoptera, Tonset, Norway (Sept. 1901), were presented by the captor, E. N. Bennett, Esq., M.A., Hertford College.

Six *Forficulidae* from Japan were presented by Harold Hornsey.

A specimen of *Melitaea aurinia* was bred in the Department (June 10, 1901); presented by Miss R. Butler, who had found the larva at Mt. Vinaigre, Var, France, in February 1901.

Additions to the British Collections in 1901.

The whole of the uncatalogued material acknowledged in the Report for 1901 has now been catalogued and incorporated, with the exception of the valuable collection of British Lepidoptera presented by W. C. Boyd, Esq., upon which a considerable amount of work in the way of printing must be expended.

Six specimens of the "Mullein Shark Moth" (*Cucullia verbasci*), bred (May, 1901) from larvae found in the Parks (July, 1900), were presented by the captor, Mr. J. Mullis.

Forty-six insects of various orders from the neighbourhood of Oxford, and a moth (*Acidalia marginepunctata*) from Weymouth, were presented by the captor, Mr. W. Holland. The

data of all specimens are most precise, and the series includes interesting sets of species with the same general type of colouring, for the bionomic series. All these insects and those recorded below, unless otherwise stated, were captured in the year 1901.

Twenty-one insects of various orders, almost entirely from the neighbourhood of Oxford, were presented by the captor, the Professor; two moths from near Rugby by the captor, E. P. Poulton, Esq., Balliol College; two beetles from near Oxford by Ronald W. Poulton; and a moth from the same locality by Janet Poulton.

A moth, from Oxford, was presented by the captor, Mr. A. Robinson.

Fifteen insects of various orders, from Oxford and near Wantage, were presented by the captor, Mr. H. Trim.

An Arachnid, from Oxford, was presented by the captor, W. G. Pogson Smith, Esq., M.A., St. John's College.

A Locustid, from near Oxford, was presented by the captor, C. J. Bayzand, Esq.

A specimen of *Sphinx convolvuli* (the convolvulus Hawk-moth), from Headington, was presented by the captor, Mr. T. Baines.

A specimen of *Sirex gigas*, from Headington, was presented by the captor, Mr. W. D. Rowles.

A specimen of *Dytiscus marginalis*, from Oxford, was presented by the captor, Mr. J. Baylis.

A hybernated queen hornet (*Vespa crabro*), from Stanton Harcourt, was presented by the captor, Mr. W. Alder.

A series of two queen hornets, two workers, and two males, from Mortimer, Berks., were presented by the captor, E. P. Poulton, Esq., Balliol College.

A male "glow-worm" (*Lampyris*), and a species of *Raphidia*, from the New Forest, were presented by the captor, Major R. B. Robertson.

A specimen of *Sirex gigas*, from Littleham Rectory, near Bideford, was presented by the captor, Rev. G. B. Simeon.

A wasp (*Vespa*, sp.) and two mimetic Diptera taken together near Cambridge, on June 9, 1901, were presented by the captor, Miss Cora B. Sanders, Lady Margaret Hall.

Ninety-four insects of various orders from the Oxford district, Devon, Suffolk, and Wicken Fen, Cambridge, were presented by the captor, Mr. A. H. Hamm. The series includes the following moths:—A set of five bred specimens of *Caradrina ambigua*, six *Apamea leucostigma*, and four *Nonagria helmanni*. Among the butterflies are two *Papilio machaon* (the "Swallow-tail") from Wicken Fen.

Sixteen insects of various orders, from Hampshire, Berkshire, and South Devon, were presented by W. J. Lucas, Esq., the captor in all cases except one.

Four specimens of *Vanessa polychoros* (the "Large Tortoise-shell"), bred from larvae found near Oxford, were presented by the captor, Harold Thompson, Esq.

A large spider (*Lycosa*, sp.) apparently introduced into the country in bananas, and found at Way & Sons, Oxford, was presented by H. Ward, Esq.; and a fine species of "cockroach" (*Blatta*, sp.), found at Oxford under similar circumstances by W. Hazell, was presented by Mr. E. Wheal.

A set of five beetles (*Trigonogenius globulum*) captured, 1900, at Oldham, by Mr. F. Taylor, were presented by Brocton Tomlin, Esq. It is believed that the species has been recently introduced into the country in American grain (Entomologists' Monthly Magazine, 1900, p. 64).

Additions to the Collection in 1902.

Many hundreds of duplicates kindly presented by the Trustees of the British Museum were included in the Collection in the course of the year. The great majority of the specimens are however in poor condition, so that they will be replaced when better can be obtained. Hence it was not considered advisable to catalogue them. In the meantime many are useful for the purpose of identification.

A bee, *Melipona apicalis*, together with an Asilid fly (*Damalina*, sp.) which was devouring it, were presented by the captor, Colonel C. T. Bingham. From the Ataran Valley, L. Tenasserim (April, 1898).

Col. Bingham also presented a Mantis, *Creoboter urbana*, captured by him in the act of eating a Pierine butterfly, *Delias descombesi*, North Shan States, Upper Burma (Oct., 1900), and a fine Asilid fly (*Microstylum*, sp.), Taunghu Valley, L. Tenasserim (May, 1893).

Two Hemiptera (*Reduviidae*), falling into the great South African group of distasteful insects, exhibiting warning colours of the type characteristic of Ethiopian Lycid beetles, were presented by W. L. Distant, Esq. Captured by Guy A. K. Marshall, at Salisbury, Mashonaland, 5,000 ft.

Thirteen Diptera of the genus *Bombylius*, including six *B. pictus*, from Hyères (Feb.–Apr., 1898), were presented by the captor, Col. J. W. Yerbury; also eight specimens of species of the same genus from South Spain (1901) and Portugal (1896), and three Diptera of the genus *Conops*, from Lahej near Aden (Mar., 1895).

A fine set of eighty-nine Diptera of the family *Asilidae*, from Karlsbad (1900), Mentone (1900), Simla (1897–8), Firozpur, Punjab (1898), Bombay (1879), and Disa (1897), was presented by the captor, Major G. C. Nurse. I have to thank Col. Yerbury for his kind help in suggesting to the donor the needs of the Department.

Sixty-nine butterflies, including a series of the extremely local *Erebia zapateri*, together with a pair of the Asilid fly *Laphria gibbosa*, of which the female was devouring a beetle, *Buprestis flavomaculata*, Albarracin Mountains, Spain (1901), were presented by the captor, Dr. T. A. Chapman.

A form of the female of the mimetic Pierine butterfly, *Euterpe eurytele*, Honduras, was presented by Col. Swinhoe, Hon. M.A., Wadham College.

A very valuable set of 336 insects, almost exclusively Lepidoptera, Southern Nigeria, West Africa (1902), was presented by C. J. M. Gordon, Esq., B.A., of Balliol College.

The rapidly growing and fine collection of African Lepidoptera in the University Museum is weakest in representatives with authentic data from the rich West Coast, so that this consignment is especially welcome. The *Lycaenidae* include three new species, which have been described by Mr. Hamilton H. Druce (Ann. and Mag. Nat. Hist., 1903) as *Larinopoda brenda*, *Epitola gordoni*, and *Pseuderesia gordoni*. In addition to these unique specimens many other Lycaenid species are new to the collection, while all are greatly wanted. The small series of *Hesperidae* and *Satyrinae* are also of great value to the collection. In the fine series of the dominant group of the *Nymphalinae* the species of the genera *Charaxes*, *Euryphene*, and *Diestogyna* are a most important accession. The data are superior to those of any specimens in the collection from this part of the world, and the great majority of specimens were captured by Mr. Gordon himself. The series also contains some valuable additions to the bionomic series: one set including two species of the genus *Euphaedra*, *E. eleus*, and *E. ruspina*, and a pair of the day-flying Hypsid moth, *Phaegorista similis*, all captured within the limits of two days (Mar. 1–2, 1902) near Benin City. All four insects possess a striking coloration belonging to a single type, and upon the wing they must closely resemble each other. Another interesting set of convergent Pierine butterflies was captured at one place and time. Other specimens illustrate the struggle for existence among insects. They include examples of two species of the distasteful genus *Acraea*, the only specimens out of a lot of about twenty left intact by ants, all the others having been devoured. The Hope Department has very rarely received so many interesting and much-needed specimens in a collection of this size.

A valuable series of 175 Lepidoptera from Central British Guiana was presented by W. J. Kaye, Esq., F.E.S. All the specimens have excellent data of locality, and a large proportion bear exact dates. Many will be of great use in the General Collection, but the chief value to the Department will be the fine addition to the bionomic series. This part of South America is remarkable for an immense and complex

group of distasteful species with varying degrees of relationship, and yet possessing warning colours in common. The great feature of this group is the tendency towards the extension and fusion of the black markings in the hind wings, until in the most extreme forms the wing is almost completely suffused with black. There is probably no group of the kind in the world which suggests more interesting problems in the past history of evolution than this association of black-hind-winged butterflies from British Guiana, and Mr. Kaye's donation will enable the Department to illustrate many aspects of the question in an admirable manner. The specimens were chiefly collected in the forest near the Potaro River, 30 miles above its junction with the Essequibo, and many of them were captured by Mr. Kaye himself.

A *Gryllotalpa* from Paraguay was presented by A. Wilkinson, Esq.

A small collection of 62 Lepidoptera and 1 beetle from British Central Africa (1901–2) was presented by the captor, Horace A. Byatt, Esq., B.A., Lincoln College. The locality renders the specimens of much value to the Department.

Eleven Coleoptera from Port Said were presented by the captors, N. Annandale, Esq., B.A., Balliol College, and H. C. Robinson, Esq.

A moth (*Dianthecia carpophaga*) from Sark (1897) was presented by the captor, W. G. Pogson Smith, Esq., M.A., St. John's College.

A specimen of the hawk-moth *Chaerocampa euphorbiae* was bred in the Department (July 15, 1902); presented by Miss O. Butler, who had found the larva (Aug., 1901) near Innsbruck.

Seven butterflies from the Kenya District of the East African Protectorate (1901) were presented by the captors, S. L. Hinde, Esq., and Mrs. Hinde. They include four specimens of an Acraea (*A. alicia*) new to the University Collection.

Fourteen insects of various orders collected in the Calvinia District of Cape Colony by H. L. Lake, Esq., and one

beetle from Tripoli, captured in 1899 by A. E. Richardson, Esq., were presented by W. J. Lucas, Esq.

In addition to the above, many kind donations of great value to the collection have not yet been catalogued and can only be provisionally acknowledged. One of the most important of these arrived close upon the end of the year from Uganda and Lake Victoria Nyanza, the gift of C. A. Wiggins, Esq. It consists of several boxes of butterflies in "papers," and the contents illustrate and help to solve many Ethiopian bionomic problems of the highest interest. It is hoped that the conclusions which follow from an examination of the specimens will be published at no distant date. It is also clear that the collections both systematic and bionomic will be very greatly enriched by this donation. From many points of view it is one of the most interesting sets of Lepidoptera ever received by the University Collections.

A large collection of insects of various orders was made by the Professor at La Granja and El Escorial in the Sierra Guadarrama, Central Spain (July, 1902). The specimens have been "set," but still require their printed labels. The collection includes a fine series of Asilid flies captured with their prey.

A splendid collection of insects of various orders was presented by Guy A. K. Marshall, Esq., on his return from South Africa, including an especially fine series of Diptera, Lepidoptera Rhopalocera, and Neuroptera Odonata. The specimens were captured in the neighbourhood of Salisbury, in Gazaland, and in Natal. They include many fine additions to the bionomic series as well as to the systematic collection. The first incontestable evidence obtained by breeding, that *Precis simia* is but the "summer" or "wet phase" of *Precis antilope*, was obtained by Mr. Marshall early in the year. A female *simia* was observed to lay eggs, two of which were successfully reared and together with the parent presented to the Hope Department. This astonishing seasonal change is figured in the Transactions of the Entomological Society of London for 1902, Plate XII, Figs. 3 (parent), 3*a* and 3*b* (offspring), Plate XIII, Figs. 4, 4*a*, and 4*b*, respectively,

representing the under sides of the wings of the insects shown on the former plate.

A valuable series of insects, chiefly butterflies from the reaches of the White Nile in the neighbourhood of the northern boundary of Uganda (1902), was presented by the captor, W. L. S. Loat, Esq., together with a collection of insects of various orders from the Blue Nile. The localities render these collections of high interest. The whole of the specimens are now "set" and provided with printed labels containing full data. The cataloguing and incorporation is only deferred until the insects have been shown at a meeting of the Entomological Society of London. Dr. Dixey has studied the Lepidoptera from the White Nile and has found the seasonal forms of much interest. It is hoped that his memoir upon the subject will appear in the course of the summer.

An interesting collection of insects of various orders with excellent data from Tenerife was presented by the captor, F. A. Bellamy, Esq.

Coleoptera from Siam were presented by N. Annandale, Esq., B.A., Balliol College.

Insects of various orders from South Africa and Norway were presented by E. N. Bennett, Esq., M.A., Hertford College.

Rhopalocera from Switzerland were presented by R. W. Lloyd, Esq.

Cocoons of five species of moths of the genus *Attacus* were presented by Mark L. Sykes, Esq., and many fine specimens were successfully bred in the Department.

A large collection of insects of various orders from tropical West Africa was presented by Dr. E. J. Crosse. Many of the specimens will be of much value to the collection. Miss E. M. Sharpe kindly suggested the needs of the Department to the donor.

Specimens of Arthropoda from tropical South America were presented by Mrs. E. S. Craig.

A valuable collection of Lepidoptera from Florida and British Columbia was presented by Dr. H. P. Allen, M.A., D.Mus., New College. The specimens were captured by his

brother, W. R. Allen, Esq., of Kaslo, Kootenay, B. C., Canada and a large proportion will be of much value to the Department.

A very fine and extensive collection of South African Hymenoptera Aculeata, from the Orange River Colony and Natal, was presented by Dr. F. N. Brown. The needs of the Hope Department were represented to the generous donor by Mr. Guy A. K. Marshall, who has done so much to enrich the University Collections.

Butterflies from Greece were presented by W. M. Geldart, Esq., M.A., Trinity College, in augmentation of the collection given by him in 1901.

Colonel Swinhoe, Hon. M.A., Wadham College, presented a fine series of 598 specimens of *Pyralidae* to the general collection of Lepidoptera Heterocera.

The collection of Diptera was enriched by a fine collection of Indian Asilidae from the neighbourhood of Poona, collected about 1888 by T. B. Fry, Esq. Presented by Col. J. W. Yerbury.

A valuable and carefully collected series of insects from various localities in N. Germany was presented by the captor, E. L. Meyer, Esq. The Hope Collections are singularly deficient in specimens from this part of Europe, so that the donation will be of unusual value.

A collection of insects from Russia was presented by the captor, H. H. Druce, Esq. In this case also the locality is hardly represented by any specimens in the University Collections.

Oriental Diptera and Hymenoptera, chiefly from Burmah, were presented by the captor, Col. C. T. Bingham.

A very fine collection of butterflies from many localities, and nearly all well "set," was presented by Herbert Druce, Esq., F.L.S.

A small collection of insects from Switzerland (1902) was presented by Miss C. B. Sanders, Lady Margaret Hall, and of insects from Kansas, U.S.A., by C. L. Pribble, Esq.

Many insects from the Eastern United States (1902) were presented by A. H. Thayer, Esq., and interesting specimens of Bornean insects for the bionomic series by R. Shelford, Esq., M.A., Curator of the Sarawak Museum, Kuching.

The following specimens were purchased in 1902. A fine series of 199 butterflies from the Kikuyu Escarpment, East African Protectorate (6,500 to 9,000 ft.) collected by the late William Doherty during Sept.–Nov., 1900, were purchased from Mr. W. F. Rosenberg and presented by the Professor. The series included 3 specimens of the Danaine butterfly *Melinda formosa* and 4 specimens of its mimic *Papilio rex*, 3 specimens of *Mimacraea dohertyi*, a beautiful Lycaenid mimic of the *klugii* form of *Limnas chrysippus*, all new to the collection. The *Mimacraea* was of much interest for comparison with the Rhodesian species, *M. marshalli*, a mimic of the type form of *Limnas chrysippus* which is dominant in that part of Africa. These specimens have been of much service in the discussion of Mr. Guy A. K. Marshall's material (Trans. Ent. Soc. Lond., 1902, pp. 470–99). There is also included a fine set of 4 males and 16 females, including all the diverse mimetic forms, of *Papilio cenea*, and many other species hitherto unrepresented in the Hope Collection.

A series of 150 Lepidoptera from La Merced, Peru (Chanchamayo and Rio Toro), was purchased from Mr. Rosenberg. Many of the specimens exhibit mimetic or Müllerian resemblances, while some possess interesting cryptic characters.

A small series of 15 butterflies was purchased from Messrs. Watkins & Doncaster. The specimens were specially wanted to add to the collection illustrating mimicry and to increase the series of forms of the Danaine genus *Limnas* which is a marked feature of the Hope Collection. Among the mimetic species is *Papilio ideoides* and its Danaine model, *Nectaria leuconöe*, from the Philippine Islands, the mimic being one of the finest examples in the world and hitherto unrepresented in the collection.

An interesting set of butterflies from New Guinea purchased from Mr. H. S. Rohu has not yet been catalogued.

Additions to the British Collections in 1902.

Four Asilid flies, Eastbourne (1900), were presented by the captor, Major G. C. Nurse.

Twenty-eight Asilid flies from many British localities, Kent, Surrey, Hampshire, Devonshire, Lancashire, Merioneth, Co. Kerry (1878–97), were presented by Col. Yerbury, the great majority having been captured by him.

Twenty-five *Asilidae* from the Oxford and Reading districts, East Ilsley, and South Devon (1898–1901), were presented by the captor, Mr. A. H. Hamm.

Seven Diptera, including 6 Asilids, from the Oxford district (1895–1901), were presented by the captor, Mr. W. Holland.

Two specimens of *Sirex gigas*, N. Devon (Aug. 1902), were presented by the captor, the Rev. G. B. Simeon, of Littleham Rectory, Bideford.

Four specimens of *Plusia moneta*, Sandhurst (July, 1902), were presented by the captor, Lieut.-Col. A. F. Mockler-Ferryman.

Eleven specimens of Hymenoptera of various groups and one Dipteron, Berkshire (June, 1902), were presented by the captor, Mrs. L. J. Veley.

Five Hymenoptera, 11 Coleoptera, and 1 Hemipteron, Berkshire (June, 1902), and a specimen of *Cetonia aurata*, Oxford (July, 1902), were presented by the captor, Miss Claridge.

A valuable set of 140 insects of different orders, and 2 Arachnids, from various localities in the New Forest and Bournemouth districts (1902), were presented by the captor, Major R. B. Robertson.

A hornet (*Vespa crabro*) from Summertown (1902) was presented by the captor, Mr. C. A. Matthews.

Dr. W. H. Jackson, M.A., D.Sc., presented the following insects captured by him in 1890–2: *Reduvius sertus* and an *Ophion* from the Oxford University Museum, a fine set of 12 *Culex annulatus* and 2 *C. pipiens* from Weston-super-Mare. These very delicate insects had been captured and

preserved with the greatest care and are in beautiful condition.

A specimen of *Reduvius sertus* from Jesus College (July 5, 1902) was presented by the captor, A. J. Chitty, Esq., M.A., Balliol College, together with a mutilated specimen of *Vanessa urticae* from the Faversham district of Kent (1902), for the bionomic series.

An Arachnid from Oxford was presented by the captor, Mr. B. Lewis.

A large Arachnid (*Lycosa*, sp.) with its egg-cocoon, was presented by Messrs. Gee Brothers. It had certainly been introduced.

A "tick" found on a recently imported tortoise was presented by T. T. Wildridge, Esq.

A hybernated specimen of *Vanessa polychloros* from Oxford was presented by the captor, Mr. W. J. Clarke.

Three specimens of *Phyllodromia germanica* found in the Randolph Hotel were presented by the proprietors. The date marks the arrival in Oxford of this rapidly spreading "cock-roach," which was introduced into England many years ago.

A pair of the rare dragon-fly, *Lestes dryas*, from Hanwell (1902), were presented by the captor, Stanley W. Kemp, Esq.

Nine insects of various orders from the neighbourhood of Oxford (1902) were presented by the captor, J. E. Pogson Smith, and 2 by W. G. Pogson Smith, Esq., M.A., St. John's College.

The "embryo nest" of a wasp (*Vespa*, sp.) built inside a deserted bird's nest, found by the River Loddon, near Reading (probably in May, 1892), was presented by E. G. Broome, Esq., B.A., Ch. Ch.

Sixteen rare or local Micro-Lepidoptera from Herefordshire (1895–1900) were presented by the captor, Dr. J. H. Wood.

A very fine addition to the British Collection is due to the generosity of H. St. J. K. Donisthorpe, Esq., F.E.S. The numerous specimens all bear accurate and detailed information of

locality and date, and constitute a most valuable accession. The insects, which are now catalogued and supplied with printed labels, include 431 Coleoptera, 117 Hymenoptera, 67 Diptera, 54 Rhynchota, 2 Orthoptera and 2 illustrations of bionomic principles. The localities are very numerous and widespread, including many in Ireland. Irish specimens have been until lately almost absent from the collection, but now the kindness of Colonel Yerbury and Mr. Donisthorpe has provided the nucleus of an Irish collection which it is hoped will continue to increase.

A valuable series of British insects has also been presented by W. J. Lucas, Esq. The insects include 20 dragon-flies (Odonata) much wanted in the collection, 4 Coleoptera, 37 Hymenoptera, 6 Diptera, 18 Orthoptera, all with excellent data. Nearly all the specimens were captured in Surrey or the New Forest, the majority in 1902. Mr. Lucas also presented two Asilid flies with their prey, from the New Forest (1902), for the bionomic series.

Important additions to the British Collections have also been presented by the following donors, and will be acknowledged in detail in the next Report:—W. G. Pogson Smith, Esq., M.A., St. John's College; W. C. Boyd, Esq.; Professor T. Hudson Beare, B.Sc., F.R.S.E.; Major R. B. Robertson; Mr. W. Holland and Mr. A. H. Hamm.

A valuable collection of insects of various orders, including many fine additions to the bionomic series, from Herefordshire and the neighbourhood of Barmouth (1902), has been presented by the captor, Col. J. W. Yerbury.

Single specimens and small collections of British insects have also been presented by the following donors:—Mr. H. Trim; W. E. Sharpe, Esq.; J. W. Tutt, Esq.; the Rev. H. A. Pickard, M.A., Ch. Ch.; the Professor, and members of his family.

An interesting collection of insects and Arachnida accidentally introduced into Bristol from Jamaica was presented by G. C. Griffiths, Esq.

Additions to the Hope Library in 1902.

The dangerous condition of many hundreds of old and valuable monographs in their original paper wrappers was brought before Convocation, and a grant of £50 was voted in order to assist in making up the arrears of binding. Many series have now been bound down to the last complete volume, and a large number of monographs have been rendered secure, especially in the Diptera, where the need was exceptionally pressing.

Two very valuable gifts have been made to the Library during the past year. The two volumes on the Rhopalocera, together with the volume of Plates (1879–1901) in the "Biologica Centrali-Americana," by F. D. Godman, Hon. D.C.L., F.R.S., and the late Osbert Salvin, F.R.S., were presented by F. D. Godman, Esq. These volumes, which are of the utmost assistance to the work of the Department, being the classical monograph on Central American butterflies, cannot be obtained apart from the costly series of which they form an important part. The Hon. Walter Rothschild gave as a generous exchange for two duplicate Indian hawk-moths a set, from its beginning in 1894, of the "Novitates Zoologicae," of which volumes i to viii are complete, and kindly consented to exchange future numbers for the "Hope Reports."

Both these accessions are now bound and in constant use.

The Secretary of State for India in Council presented the volume on Arachnida by R. I. Pocock (London, 1900), and that on Rhynchota (Heteroptera) by W. L. Distant, vol. i. (London, 1902), in "The Fauna of British India" series.

The Smithsonian Institution (United States National Museum, Washington) presented The Annual Report of Regents for the year ending June 30, 1900 (Washington, 1902), and valuable memoirs by the following writers:— August Busck, Esq.; James E. Benedict, Esq. (two memoirs); William Schaus, Esq.; Ralph V. Chamberlin, Esq.; Miss Mary J. Rathbun (two memoirs); Warren Elmer Hindes, Esq.; Miss Harriet Richardson; Charles Branch Wilson, Esq.; William Perry Hay, Esq. (two memoirs); Henry Ulke,

Esq.; Harrison G. Dyar, Esq.; Nathan Banks, Esq.; Dr. John B. Smith, Sc.D.; D. W. Coquillet, Esq.

The University of the State of New York presented a fine set of Reports of the State Museum for 1898 and 1899 (52.1, 52.2, 53.1, 53.2).

The Radcliffe Librarian, Oxford, presented the Catalogue of Books added during 1901.

The United States Department of Agriculture presented "A Biological Investigation of the Hudson Bay Region," by Edward A. Prebble, Esq. (Washington, 1902).

The Boston Society of Natural History and the Bombay Natural History Society presented their publications for the year 1902. The latter series, complete from the beginning, was in the original paper covers and most unsafe. It has now been bound down to the last complete volume. The early volumes of the Boston Society of Natural History were bound, and in arranging the others for the binder it was found that many parts were wanting. The Professor wrote to the Secretary of the Society, who very kindly supplied the missing numbers so far as they were still available. All complete volumes have now been bound.

The Superintendent of the Museum of Zoology, Cambridge, presented the Report of the Syndicate for 1901.

"Studien zur Descendenz-Theorie" (Leipzig, 1875, 1876), by Dr. August Weismann, Hon. D.C.L., was presented by Professor Raphael Meldola, F.R.S. The copy is that used in the preparation of the well-known English edition of the work, and it is rendered interesting and valuable by the inclusion of a number of manuscript notes from the author, and of marginal notes by the translator and editor of the English edition, Professor Meldola.

Parts III and IV of the "Monograph of the Membracidae" were presented by the author, George Bowdler Buckton, Esq., F.R.S., F.L.S.

A Monograph on "The Tettigidae of North America" (Chicago, 1902) was presented by the author, Joseph Lane Hancock, Esq.

"A List of British Diptera" (Second Edition, Cambridge, 1901) was presented by the author, G. H. Verrall, Esq.

"The Moths of South Africa" (Part II), from the "Annals of the South African Museum" (1902), a supplementary paper to "The Moths of India," and "New Species of *Syntomidae* and *Arctiadae*," were presented by the author, Sir G. F. Hampson, Bart., M.A., F.Z.S., &c.

A fine series of twenty-nine memoirs chiefly dealing with the Malacoderm beetles, including the monograph "Faune Gallo-Rhénane: Coléoptères," tome quatrième (Caen, 1894), was presented by the author, M. Jules Bourgeois.

A fine series of eighteen memoirs, chiefly upon the Orthoptera, including "Catálogo sinóptico de los Ortópteros de la Fauna Ibérica" (Coimbra, 1900), was presented by the author, Señor Don Ignacio Bolivar.

Six memoirs, principally from the Proceedings and Transactions of the Royal Society (1895–1900), were presented by the author, H. M. Vernon, Esq., M.A., D.M., Magdalen College. These papers, containing an account of the author's experiments on fertilization, hybridization, the effect of environment, variation, &c., will be a valuable addition to the section of the Hope Library including works on evolution, bionomics, &c.

The same part of the Library was enriched by Dr. A. G. Mayer, who presented his memoir, "Effects of Natural Selection and Race-tendency upon the Colour-patterns of Lepidoptera" (New York, 1902), and by Guy A. K. Marshall, Esq., who presented three papers dealing with various bionomic problems presented by the insect fauna of South Africa.

Five memoirs upon Coleoptera, one upon the Homopterous family *Membracidae*, and the Presidential Address to the Entomological Society of London (Jan. 15, 1902), were presented by the author, the Rev. Canon Fowler, M.A., D.Sc., F.L.S., Jesus College.

Two memoirs on Crustacea, including "South African Crustacea" (Part II, 1902), were presented by the author, the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., Worcester College.

Dr. H. J. Hansen presented his monograph "On the Genera and Species of the Order Pauropoda" (Copenhagen, 1902).

Of special interest and value to the Department are the separate copies of publications in which new species in the Hope Collection are described. Thus two papers on Coleoptera, one of which contains a description of *Spodistes hopei*, were presented by the author, Gilbert J. Arrow, Esq., F.E.S.; and a memoir upon many new and little-known Lycaenid butterflies was presented by the author, Hamilton H. Druce, Esq., F.Z.S., F.E.S. Among the new *Lycaenidae*, the types of *Waigeum ceramicum*, *Horaga amethystus* (female), and *Ialmenus clementi* are in the University Collection.

Original papers have also been presented by the following authors:—Frank Collins Baker, Esq.; Lieut.-Colonel C. T. Bingham (two papers); Professor N. Leon; Lieut.-Colonel J. W. Yerbury (late R.A.), F.Z.S., F.L.S.; Frank Bouskell, Esq., F.E.S., F.R.H.S.; Edward Saunders, Esq., F.R.S., F.L.S.; Colonel J. G. Pilcher, F.R.C.S.; and William Schaus, Esq.

The parts of Barrett's "British Lepidoptera," the Ray Society Volume, the volume of the Zoological Record for the year 1902, and the numbers of the "Entomologists' Monthly Magazine," the "Entomologist," and the "Entomologists' Record" were purchased for the Department, together with Dr. J. R. Schiner's "Die Wiedemann'schen Asiliden" and five supplementary parts of Macquart's "Diptera exotique," thus completing the imperfect copy of that valuable work.

EDWARD B. POULTON.